

No.163

WIN 2 x 500ml BOTTLES OF METCUT MCT LIQUID
Advanced Metal Cutting Lubricant courtesy of Morris Lubricants



MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

MAY 2010

**68 FULL
COLOUR
PAGES**

**HIGH PROFILE
END CLAMPS**

**ONE-SHOT
LUBRICATION
SYSTEM UPDATE**

**MAKING A
SUB TABLE
FOR A MILLING
MACHINE**

**A NEW C3
MINI-LATHE
FROM SIEG**

**EDGE AND
CENTRE
FINDING**

**MYFORD
SERIES 7 FRONT
SADDLE CLAMP**

**USING A TOOL
LIBRARY ON A MILL**

**CNC MILLING
USING SUBROUTINES
WITH MACH3**



£3.95



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Precision Machines Made in Germany
"For the discerning engineer"



D2000E

Centre distance 350 mm
Centre height 110 mm
Power 1,4 kW, 230 V, 50 Hz
Spindle speed infinitely variable
45 - 2300 r.p.m.
Feed 0,085 and 0,16 mm



D3000E

Centre distance 500 mm
Centre height 110 mm
Power 1,4 kW, 230 V, 50 Hz
Spindle speed infinitely variable
45 - 2300 r.p.m.
Feed infinitely variable 0 - 250 mm/min



D4000E

Centre distance 350 mm
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Power 1,4 kW, 230 V, 50 Hz
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CC-D6000E

CC-D6000 E with safety machine cabin and integrated coolant unit, ball screws, automatic 8-station tool changer and base cabinet



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180 - 3000 r.p.m.



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Power 2,0 kW, 230 V, 50 Hz
Spindle speed infinitely variable
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Feed 0,085 and 0,16 mm

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are offered with a variety
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software systems, and
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ON THE COVER

Locating the centre of a spigot. See article on page 26. Photo by Michel Christiaens



Please see page 8 for our latest subscription offer.

WARCO

WARCO
Our next exhibition
The National Model
Engineering Exhibition
Harrogate
7th-9th May 2010
See you there!

GREAT DEALS

THAT REALLY MEASURE UP!

NEW

WM-14 VARIABLE SPEED MILL

An updated version of this established, popular, compact, variable speed milling machine.

Now fitted with easy to read digital rev. counter.

Fine feed to quill travel. Similar to WM16 mechanism.

New easy to reach emergency stop switch.

All these new features at the original price of £635.00, including VAT and UK mainland delivery for a limited introductory period.

- Available with metric or imperial leadscrews
- Back gear for maximum torque
- Table size: 400 x 120mm
- 2MT Spindle with captive drawbar
- Longitudinal travel 220mm
- Cross travel 160mm
- Head travel 210mm
- Tilting head

£635.00



WM-18 VARIABLE SPEED MILL MACHINE

- Available with metric or imperial leadscrews
- Back gear for maximum torque
- New larger table
- Table size: 840 x 210mm
- 3MT Spindle
- Longitudinal travel 565mm
- Cross travel 220mm
- Head travel 370mm
- Tilting head

Reviewed by Model Engineer Workshop issue no. 153.

Following workshop trials, David Fenner said, "I rate this as a very competent machine. I was pleasantly surprised at the lack of mechanical spline noisealso the near absence of gear noise"

£1,250.00

including VAT and UK mainland delivery



Longitudinal power feed available in April, for retro-fitting, £199.00, including VAT and UK mainland delivery.

• Cabinet stand and full range of accessories available.

VMC TURRET MILL



- Long term favourite
- Available with metric or imperial leadscrews
- Choice of R8 or 3MT spindle
- Knee located on ground dovetails with adjustable gibs for positive location
- Supplies with halogen lighting and centralised lubrication system to slideways and leadscrews
- Option DRO, power feeds, wide tray, foot switch

£1,550.00

including VAT and UK mainland delivery

BV20 LATHE



- All geared head
- Centre height 100mm
- Distance between centres 350mm
- Supplied with 3 and 4 jaw chucks, fixed and travelling steadies, swarf tray and rear splash guard
- Metric and imperial threading
- Available with either metric or imperial leadscrews and dials
- Optional stand £135.00, if supplied with a lathe

To include free of charge live centre, drill chuck/arbor and 5 piece set of Indexable lathe tools.

SPECIAL OFFER PRICE

£690.00

including VAT and UK mainland delivery

WMT300 LATHE

£799.00

including VAT and UK mainland delivery



Special offer free of charge revolving centre and 5 piece Indexable lathe tool set

- Supplied with 3 jaw chuck, fixed and travelling steadies, face plate, drill chuck, metric and imperial change gears
- Centre height 150mm
- Distance between centres 500mm
- Large Spindle bore 26mm

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NEW Products from Arc Euro Trade

Unbeatable Value Engineering Products by Mail Order



NEW Super C3 Mini Lathe

It's a tough task improving on an already successful product, but that's what SIEG have done with the C3 Mini Lathe.

The New **Super C3 Mini Lathe** has a powerful state-of-the-art 500w Brushless DC motor and variable speed controller to drive it. The 2 speed gearbox has gone because the brushless motor has far better torque even at the slowest speed.

The **Super C3** also has an even longer bed giving you 400mm between centres and a covered leadscrew to keep it swarf and chip free.

Specifications:

Swing Over Bed:	180mm
Distance Between Centres:	400mm
Hole Through Spindle:	20mm
Spindle Taper:	MT3
Tailstock Taper:	MT2
Spindle Speed:	100-2500 rpm
Thread Cutting	
Super C3 Metric:	0.4-2.0mm
(10 Metric pitches)	
Super C3 Imperial:	12-52tpi
(8 Imperial pitches)	

Motor Output:	500w Brushless DC
Weight (net/gross):	40kg/50kg
Overall Dims:	800x320x330mm

Standard Equipment: 80mm 3 Jaw Chuck, MT2 Dead Centre, Gear Set, Oil Tray, Tool Kit.

Super C3 Mini Lathe Promotional Price: £451.00

(Normal Price £481.00 saving you £30.00) (Subject to availability)

080-020-00320	Model Super C3 Mini Lathe - Metric	£451.00	+£25.00
080-020-00330	Model Super C3 Mini Lathe - Imperial	£451.00	Carriage
080-020-00340	Model Super C3 Arc Preparation Service	£120.00	
090-020-01500	Super C3 Digital Speed Display	£67.00	

Even Longer Bed:
400mm Between Centres

NEW Range of Abrasive Products

Proflex Grinding and Cutting Discs



Manufactured to high quality and safety standards.

Diameter: 115mm
(4 1/2")
Bore: 22mm

180-001-00200	DPC Grinding Disc 6mm Thick	£1.00
180-002-00200	Flat Cutting Disc 3mm Thick	£0.75
180-003-00100	Extra Thin Flat Cutting Disc 1mm Thick	£1.00

Zirconium Flap Discs

Manufactured from premium quality Zirconium grit and sturdy fibre backing. Designed for long life and with the versatility expected from flap discs.

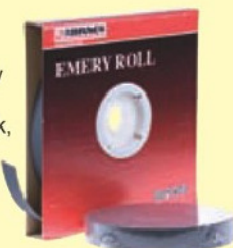


Diameter: 115mm (4 1/2") - Bore: 22mm
Profile: Bevelled

180-004-01040	40 grit	£1.85
180-004-01060	60 grit	£1.85
180-004-01080	80 grit	£1.85
180-004-01120	120 grit	£1.85

Emery Rolls

Premium quality aluminium oxide grit bonded to strong but easy to tear cloth backing. For general maintenance work, rust removal, sanding and polishing and ideal for use in the automotive and engineering industries.



Emery Rolls

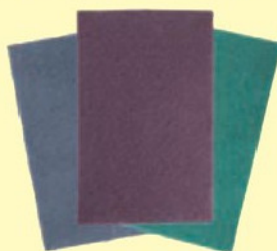
Roll Width: 25mm
Roll Length: 25m (shrink wrapped)
50m (dispensing box)

180-005-01040	25m long	40 grit	£7.50
180-005-01080	25m long	80 grit	£7.50
180-005-01120	25m long	120 grit	£6.75
180-005-01150	25m long	150 grit *	£6.75
180-005-01180	25m long	180 grit *	£6.75
180-005-01280	25m long	280 grit *	£6.75
180-005-02040	50m long	40 grit	£13.95
180-005-02080	50m long	80 grit	£12.95
180-005-02120	50m long	120 grit	£10.95
180-005-02150	50m long	150 grit *	£10.95
180-005-02180	50m long	180 grit *	£10.95
180-005-02280	50m long	280 grit *	£10.95

(* Finer grit sizes just added to range)

Industrial Hand Pads

Industrial hand pads suitable for a variety of cleaning and finishing applications. Constructed from a 3-dimensional non-woven web and impregnated with aluminium oxide abrasive, these pads won't rust even when used with water or solvent.



Size: 230x150mm
Supplied as single sheets.

180-006-00100	Coarse (Maroon)	£0.75
180-006-00200	Medium (Green)	£0.75
180-006-00300	Fine (Grey)	£0.75

Bench Grinder Wheels - Aluminium Oxide

Made from premium quality aluminium oxide, each wheel is speed rated and comes complete with plastic reducing bushes incorporating bore sizes 32mm, 25mm, 20mm, 16mm and 1/2".



For general purpose use.

180-007-03036	ø150x20mm wide 36 grit	£10.50
180-007-03080	ø150x20mm wide 80 grit	£10.50
180-007-03120	ø150x20mm wide 120 grit	£10.50
180-007-07036	ø200x20mm wide 36 grit	£18.50
180-007-07080	ø200x20mm wide 80 grit	£18.50
180-007-07120	ø200x20mm wide 120 grit	£18.50

Bench Grinder Wheels - Silicone Carbide (Green Wheels)

Made from premium quality silicone carbide, each wheel is speed rated and comes complete with plastic reducing bushes incorporating bore sizes 32mm, 25mm, 20mm, 16mm and 1/2".



For grinding Tungsten Carbide tooling.

180-007-04080	ø150x20mm wide 80 grit	£11.50
180-007-08080	ø200x20mm wide 80 grit	£20.50

All Prices Include VAT

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• All prices include V.A.T. • P&P is extra and calculated on weight • Postage prices start from £0.95

Solar Powered Caliper...



- Metric/inch conversion.
- Digital measurements without batteries.
- Storage case.

Part no	Range	WAS	SALE
ME-CAL-SOL-150	0-150mm/6"	£34.95	£27.96

Depth Gauges...



- Digital depth gauge with internal step measuring hook*.
- *not present on ME-DEPTH-500.
- 100mm base size.

Part no	Range	WAS	SALE
ME-DEPTH-150	2-150mm/6"	£29.95	£23.96
ME-DEPTH-300	2-300mm/12"	£39.95	£31.96
ME-DEPTH-500	0-500mm/20"	£49.95	£38.76

Quill Clamp DTI Holder...

- Fits to most machines.
- 42mm to 54mm clamping range.

Part no	WAS	SALE
MT-QU-CLAMP	£9.95	£7.96

Cutter Tool Trays...

- Store milling cutters, drill bits, taps, solder tips etc..
- 102mm (4") wide, 215mm (8 1/2") long & 22mm (7/8") high
- Tough plastic.



£1.25 EACH *cutters/drill bits not included.

Left Handed Caliper...

- Left handed with the jaws opening to the left.
- Metric/imperial conversion.
- Comfortable left handed lathe work measurement.
- Storage case.



Part no	Range	WAS	SALE
ME-CAL-LH-150	0-150mm/6"	£29.95	£23.95

Magnetic Stand...

- Vee base and ground side face.
- Rigid locking mechanism.
- Fine screw adjustment.
- Dovetail & ring clamp indicator fixing.

Part no	WAS	SALE
MT-MG-BASE	£29.95	£23.95



Digital Angle Finder 200mm...

- Lock arm at any angle through 360 degrees.
- Absolute & relative display.
- Large LCD display.
- 200mm arm length.
- Spirit level bubble on top face.
- Aluminium body & stainless Arm.
- 0.05 degree resolution.

Part no	Range	WAS	SALE
ME-AN-MEAS	0-360°	£36.95	£29.56



Digital Indicator...

- Large easy to read LCD.
- mm / Inch.
- Set Zero at any position.

Part no	Range	WAS	SALE
ME-DI-IND-10	0-10mm / 3/8"	£39.95	£31.96
ME-DI-IND-30	0-30mm / 1 3/16"	£52.95	£42.35
ME-DI-IND-50	0-50mm / 2"	£64.95	£51.96



Dial Test Indicator- Imperial DTI...

- Automatic reversal.
- Dovetail mounted spigot, with dovetails on 3 sides.
- 1/4" and 3/8" mm diameter spigot
- 30mm dial diameter.

Part no	WAS	SALE
ME-IM-DIAL-DTI	£29.95	£23.96



Depth Gauge (pin type)...

- Depth gauge with round pin.
- 60mm base size.
- Storage case.

Part no	Range	WAS	SALE
ME-DEPTH-30	0-25mm/1"	£24.95	£19.96



Vertical Digital Scales...

- mm / Inch.
- Set Zero at any position.
- Mounting bracket supplied.
- Data output.

Part no	Travel	WAS	SALE
ME-VT100	100mm/4"	£32.95	£26.36
ME-VT150	150mm/6"	£34.95	£27.96
ME-VT200	200mm/8"	£39.95	£31.96
ME-VT300	300mm/12"	£54.95	£46.36
ME-VT400	400mm/16"	£64.95	£53.57



Digital Angle Gauge...



- Digital angle/inclinometer.
- Zero calibration function.
- 0.1 degree resolution.
- Magnetic base.
- Compact size (51x51mm).

Part no	Range	WAS	SALE
WR300-KIT	+/- 180°	£28.95	£22.50

Dial Bore Gauges...

- Measure bore diameter, or detect a taper or ovality.
- 55mm diameter dial indicator.
- 0.01mm resolution.
- Long reach stem.

Part no	Range	Reach	WAS	SALE
ME-BG-10-18	10-18mm	100mm	£44.95	£35.96
ME-BG-18-35	18-35mm	130mm	£44.95	£35.96
ME-BG-35-50	35-50mm	150mm	£34.95	£27.96
ME-BG-50-160	50-160mm	150mm	£44.95	£35.95
ME-BG-160-250	160-250mm	500mm	£69.95	£55.96

Imperial Caliper with Fractions...

- Imperial calipers with fractions 1/16, 1/2 etc..
- Displays decimal inches and fractions simultaneously

Part no	Range	WAS	SALE
WR100	0-150mm/6"	£32.95	£26.36

Co-ax Centering indicator...

- Simple method of centering a workpiece or assembly.
- Dial face remains stationary.
- Can be used horizontal or vertical.
- Internal or external setting.

ONLY £67.96
Part No. ME-DIAL-CENT



Horizontal Digital Scales...

- mm / Inch.
- Set Zero at any position.
- Mounting bracket supplied.
- Data output.

Part no	Travel	WAS	SALE
ME-HZ100	100mm/4"	£24.95	£21.55
ME-HZ200	200mm/8"	£32.95	£26.36
ME-HZ300	300mm/12"	£41.95	£33.56
ME-HZ400	400mm/16"	£54.95	£43.95
ME-HZ450	450mm/18"	£62.95	£50.36
ME-HZ600	600mm/24"	£79.95	£63.96
ME-HZ800	800mm/31 1/2"	£129.95	£107.96



Digital Readout Systems...



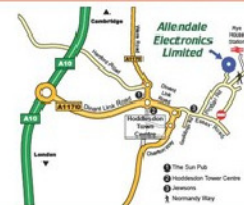
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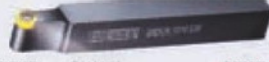
BORING

CODE	SHANK	PRICE
XC34	6MM	£18.50
XC35	8MM	£18.50
XC36	10MM	£19.50
XC37	12MM	£21.00
XC38	16MM	£23.00
XC48	10 INSERTS	£23.95



PROFILING

CODE	SHANK	PRICE
XC39	6MM	£15.00
XC40	8MM	£16.00
XC41	10MM	£17.00
XC42	12MM	£20.00
XC49	10 INSERTS	£24.95



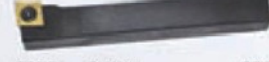
RH TURNING

CODE	SHANK	PRICE
XC43	6MM	£15.00
XC44	8MM	£16.00
XC45	10MM	£16.50
XC46	12MM	£17.50
XC47	16MM	£23.00
XC48	10 INSERTS	£23.95



LH TURNING

CODE	SHANK	PRICE
XC83	6MM	£15.00
XC84	8MM	£16.00
XC85	10MM	£16.50
XC86	12MM	£17.50
XC87	16MM	£23.00
XC48	10 INSERTS	£23.95



PARTING



CODE	SHANK	PRICE
GX67	10 X 10MM	£26.95
GX68	12 X 12MM	£27.95
GX69	16 X 16MM	£29.95
GX70	20 X 20MM	£33.95
GX71	INSERT FOR 10, 12 & 16MM	£ 4.50
GX72	INSERT FOR 20MM	£ 4.50

CLAMP TYPE PARTING



CODE	SHANK	PRICE
CGG081	8MM	£25.95
CGG101	10MM	£31.00
CGG121	12MM	£33.00
CGG122	16MM	£35.00
CGG120	20MM	£36.00
CGGSP	INSERT FOR 8-16MM	£ 4.50
CGGSP20	INSERT FOR 20MM	£ 4.50

GLANZE SCLCR INDEXABLE LATHE TOOL SETS C/W 7 CARBIDE CCMT INSERTS



CODE	SHANK	PRICE
XC50	8MM	£ 84.00
XC51	8MM	£ 84.00
XC52	10MM	£ 90.00
XC53	12MM	£ 98.00
XC54	16MM	£135.00

METRIC THREADING INTERNAL

CODE	SHANK	PRICE
722100	10MM	£25.00
722210	12MM	£25.00
SIR016	16MM	£29.95
1116160	INSERT 10 & 12MM	£ 7.25
1116A60	INSERT 16MM	£ 7.25



METRIC THREADING EXTERNAL

CODE	SHANK	PRICE
775100	10MM	£25.00
775118	12MM	£25.00
SER16K16	16MM	£29.95
11ER1A60	INSERT 10 & 12MM	£ 7.25
A6ERAA60	INSERT 16MM	£ 7.25



GLANZE DCMT INDEXABLE LATHE TOOLS

INC THREADING TOOL, BORING TOOL & 2 TURNING TOOLS

CODE	SHANK	PRICE
XC55	8MM	£52.50
XC56	10MM	£54.00
XC57	12MM	£62.00
XC58	16MM	£74.00
XC59	INSERT	£ 4.00



NEW! FROM GLANZE! SWUCR 02 MINIATURE BORING BAR

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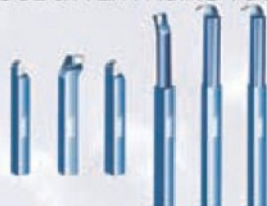
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David Clark

Myford open day

If you are a subscriber, this magazine should reach you just before the Myford open day. You should still have time to make a visit. If you have purchased this magazine from your newsagent you may still have time to visit on Saturday 17 April. This is a very busy event and is well supported by local clubs and a couple of trade stands. I am looking forward to visiting again, I went last spring and thoroughly enjoyed myself.

Transwave competition

I am visiting Transwave (Power Capacitors) on the Wednesday prior to the Myford Show. Pete Moss has offered us one of his products for a competition to be held in Model Engineer, Model Engineers' Workshop and on our website www.model-engineer.co.uk

Details are still to be finalised but it will be a valuable prize. You will be able to enter online or using the form in ME or MEW. Photocopies will be acceptable but postal entries must be on the form.

Harrogate Exhibition

Remember to visit the Harrogate Exhibition on May 7, 8 and 9. When you visit, be sure to have a look at Ray McMahon's Darjeeling Himalayan 0-4-0 tank locomotive. Ray has written up this loco, taken loads of photographs and supplied a full set of drawings for publishing in Model Engineer. I hope to start this series very soon after arriving back from Harrogate. I am really looking forward to seeing this locomotive series.

Harrogate is the big show in the North of England, especially for those interested in traction engines, steam locomotives, model aircraft, model railways, boats and road vehicles. I expect coach parties will be arriving from all over the country. There are two huge exhibition halls packed with hundreds of models, over 40 club and society stands and one of the largest trade exhibitions in the UK. Opening times are 10am to 5pm (closes at 4.30pm on Sunday). Adults: £10, Over 65s: £9, Under 16s: £3, Under 5s: Free. Contact Richard Ashworth: 08432 897931. I expect to be there for all 3 days. The Model Engineer deputy editor, Kelvin Barber, will also be attending.

Yorkshire Event Centre, Great Yorkshire Showground, Harrogate HG2 8PW.
SatNav: HG2 8QZ

Book your accommodation early, most hotels and B&Bs will be sold out well before the exhibition.

ON THE EDITOR'S BENCH

We are expanding

An announcement by Arc Euro Trade Ltd.

Visitors to our warehouse, as well as some of our regular customers, will be aware that we have put our premises at 10-12 Archdale Street up for sale. The FOR SALE board states "business relocating". If all goes according to plan, we are hoping to move to larger premises during the months of May/June this year. We will announce details of the new address nearer the date.

This will mean that we will be unable to attend the Harrogate Show, and we would like to express our apologies for the inconvenience this will cause our friends and customers who would normally expect to see us there.

Until further announcements are made, it is business as usual at Arc Euro Trade Ltd. - still operating out of 10-12 Archdale Street in Leicester. www.arceurotrade.co.uk

If I am informed of future developments, I will be happy to post them on our website, this will be faster than printing them in the magazine although we will still do this of course. I would like to wish Arc Euro Trade good luck for the move and best wishes for their future. Ed.

New Super C3 Mini-Lathe

Arc Euro Trade has launched a new version of the popular C3 Mini-Lathe. The C3 now has a higher torque brushless DC motor and a longer bed that will accept 400mm between centres.

Certain questions have been asked on the website forum, the main one being "Can I put the new motor onto my old C3 or onto another machine such as a Myford?" The simple answer is no. The mountings are different as the bed has undergone a revamp. Also, any spare motors at the moment will be reserved for after sales service. They will not be available separately for a while. The best bet is to sell your old C3 and buy a new one. I would place your order soon as they are sure to sell out quickly.

No truth in the rumour

Blackgates and Reeves 2000 would like it known that there is no truth in the rumour that they are selling up or closing down. Blackgates did suffer a break in a while back where most of the non ferrous castings, amongst other bits, were taken resulting in a short delay while further stocks were obtained. Both firms are open for trading as usual and will continue to be for the foreseeable future.

CNC articles

There are slightly more than usual, articles about CNC in this issue, in fact, Mick Knights has had 3 articles included. His articles are all slightly related so it made sense to include them all together in one

issue. The tool stand could be used with a manual machine so is still a useful article for most readers.

3D Design

A few people wrote in to complain about this series. Many more wrote in to congratulate Linton Wedlock for writing it. I would love to learn 3D design but don't have the time to sit down and do it. It takes me long enough to do 2D in TurboCAD although I am now getting to grips with it. A selection of letters are included in Scribe a Line.

In the workshop

Easter Friday is in less than 48 hours away as I write this. As long as the weather is fine, I will be spending time in the workshop. I final effort putting up hooks and other storage will mean that I can go out into the workshop and start work immediately whenever I want. There is nothing worse than going into the workshop, stepping over lots of boxes to get at the machines then finding that you can't find that necessary tool, cutter or collet. I am an untidy worker, it comes from many years in industry where you have to get the job done and do it now. There was never any time to clean up properly except on Christmas Eve before leaving early at lunchtime.

New camera

I have treated myself to a new camera, A Panasonic Lumix FS30 with 14Mega Pixels resolution and a 28mm wide angle lens. This should make workshop photography a lot easier than previously. I took photos at Myford's open day last year but was never very happy with them. They looked sort of grainy. Although I used two totally different cameras, both sets of photos looked the same on screen. Hopefully this year will see some better photos suitable for putting in the magazine. Perhaps I will try the after dark mode?

New web editor

Kelvin Barber has taken over the role of web editor as part of his change of role to deputy editor of Model Engineer. Richmond is no longer a moderator and has moved on. Thank you Keith (Richmond) for all the work you did for the first 10 months of the website going live. Best wishes for the future.

The website is going up in numbers, well over 5,000 members at the time of writing. I expect that membership will rise to over 6,000 before the next issue is out. I will be giving a prize to the 6,000th member to join our community. Go on, join up today. It only takes a few minutes. I know many of you just look at the website without joining up. Now is the time to join, do it today. Enter our competitions; ask your questions on the forum, post photos of your latest project. You will find we are a friendly lot.

fence, ensuring that one edge is firmly against the angle plate and the hole F at the top. Mount the angle plate onto the milling machine table.

Take an M6 screw and create a slight taper on the end and screw this fully into hole E dropping the 6mm diameter ball into the hole. Unscrew the screw slightly so that the ball falls well back into the hole and start machining the angled edge, lowering the cut until it is down to the mark made to define the position of the 14mm edge (**photo 20**). Now, wind in the screw fully and note the ball is being raised above the machined surface. This needs to be sufficient to ensure that it will eventually clamp the carrier in its chosen position. I would suggest 0.5mm above the surface. If less, the ball can be lowered and a little more machined off as the 14mm dimension is not critical, then test once more.

Remove the carrier, rotate, and again fit to the fence ensuring that the part is against the angleplate and machine the second end to produce a flat 26mm wide. Do not be concerned regarding the 12/14mm dimensions as the position of hole D is not crucial.

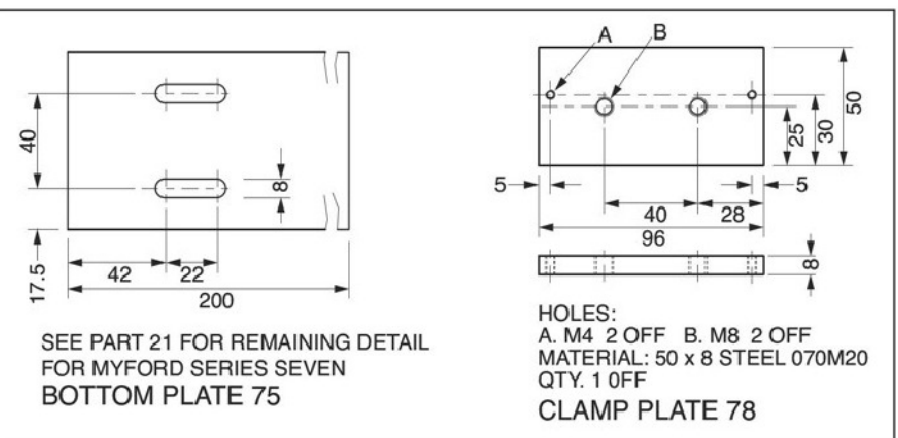
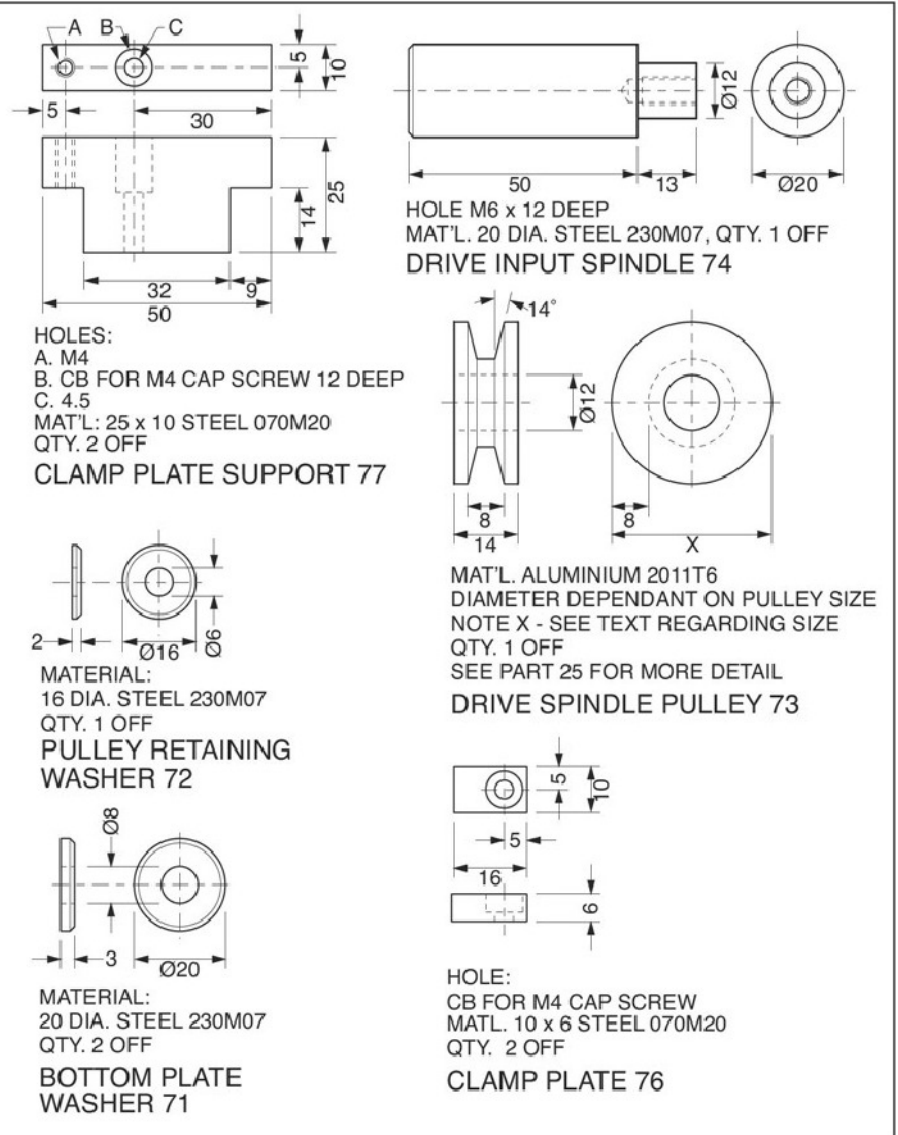
Body (51)

Cut a piece of 60mm diameter steel to 20.5mm long, place in the 3-jaw chuck and face the first end, reverse in the chuck, face the second end and produce holes A and B. If you would like the outer diameter to have a machined surface, produce a mandrel with a short spigot to fit the counterbore and tap M6. Mount the workpiece on this and skim the outer diameter.

Mount the body on an angle plate, if possible with its outer diameter level with the bottom and right hand edges as this will avoid any calculation, see rear left of photo 2 in issue 161. With that done scribe machine-to lines for the 12 and 14mm dimensions then turn the angleplate on its end and similarly for the 15 and 21mm values. As none of these are critical it will avoid any need for measurement during the machining process.

If you do not have a few tee nuts with smaller than normal tapped holes, now is the time to make some, say two off M6 and two off M5. Loosely mount the body on the milling machine table with an M6 screw into an M6 tee nut. Place a 300mm rule on top of the body, aligning it with one of the scribed lines, and rotate until the rule appears to be in line with the table's axis. Visually should be adequate as precision is not required. With that done, tighten the central screw. Do not rely solely on this though adding two bar clamps as seen in **photo 21**. The photograph shows that the bulk of the material is being removed with a normal end mill prior to producing the dovetails with a dovetail cutter.

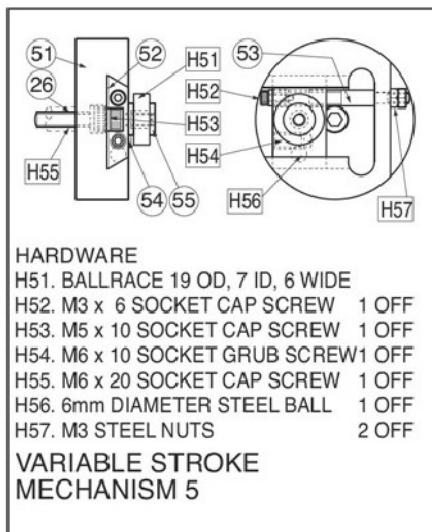
As I have added X axis (back/front) stops to my milling machine, I was able to carry out the initial metal removal by machining along the back edge, down the right hand side and returning along the front edge, all without reference to leadscrew dials, making it a simple operation. If you do not have X axis stops, perhaps this is the time to consider adding them. Following that mount a 10mm end mill and machine the recesses shown and also the step that creates the 21mm dimension, taking note that this is deeper than the recess.



The dovetails must though be produced one side at a time, so starting on the rear edge gradually increased the depth until the upright surface produced by the end mill is just removed. Next produce the front dovetail but this time, to avoid the cutter grabbing the workpiece, (down milling) the dovetail should be started at the right hand end moving towards the left of the workpiece. When a full dovetail approaches check with the bearing carrier, gradually increasing the depth until the recesses just enters freely; a close fit is not necessary. If you are using a large diameter dovetail cutter you will have to



21. Initial machining of the body prior to making the dovetail faces.



permit it to machine into the end wall of the recess.

Finally, having removed the part from the machine table, fit the bearing carrier near to the web at the end and clamp in position using the screw and ball clamping mechanism and then, with a drill that just passes through the M6 tapped hole, spot through so as to set the position for the 4.5mm diameter hole. Remove the carrier and drill the 4.5mm diameter hole to take the feed screw.

The turned parts

These parts, 53 - 55 are simple components and need no explanation.

Table assembly (6)

This is the final assembly (apart from the Myford mounting assembly and guard) as shown in **photo 22** and has one interesting component, the table pivot (61).

Cut two pieces of 25 x 8mm steel and machine to 40mm long. Mark out the position of the two tapped holes and machine-to lines for the ends of the curved slot. Make also a locating fence as shown by **Sk.1**.

As a rotary table is one of the lesser used workshop items, I will describe the process in detail aided by three photographs. Place the rotary table on the milling machine and fit with a centred setting plug. With a centre fitted into the machine spindle lower this into the plug, **photo 23**, and fix the rotary table in this position. Do not now move the milling machine table, lock it in both the X and Y axis. In view of not being able to move the rotary table after it is positioned do ensure, prior to carrying out this process, that there will be sufficient height to fit the milling cutter chuck.



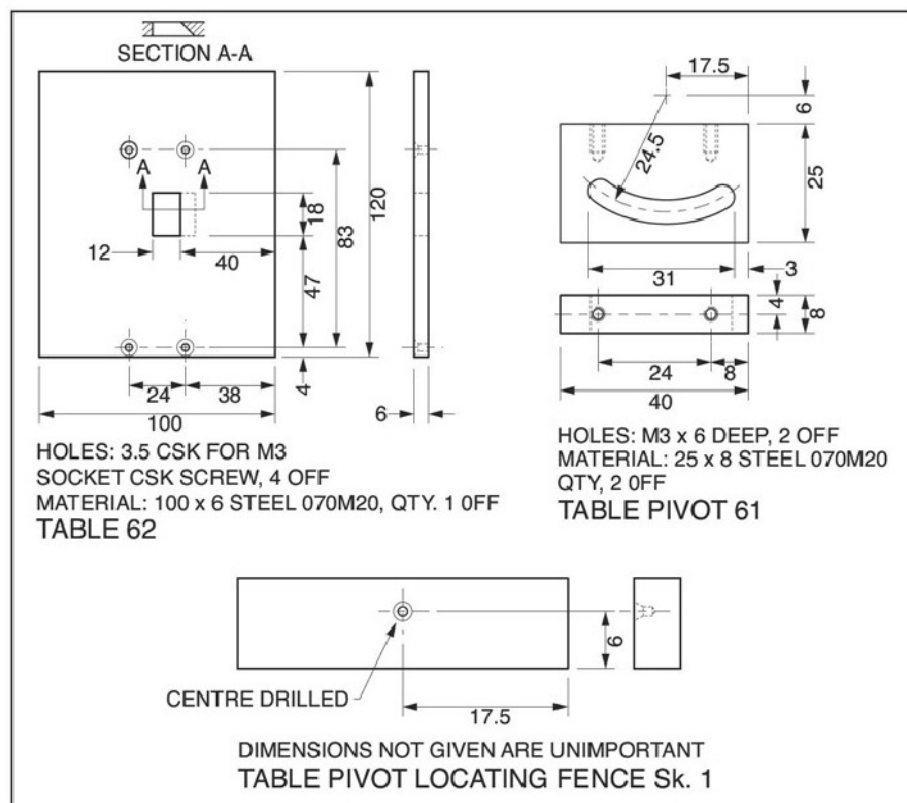
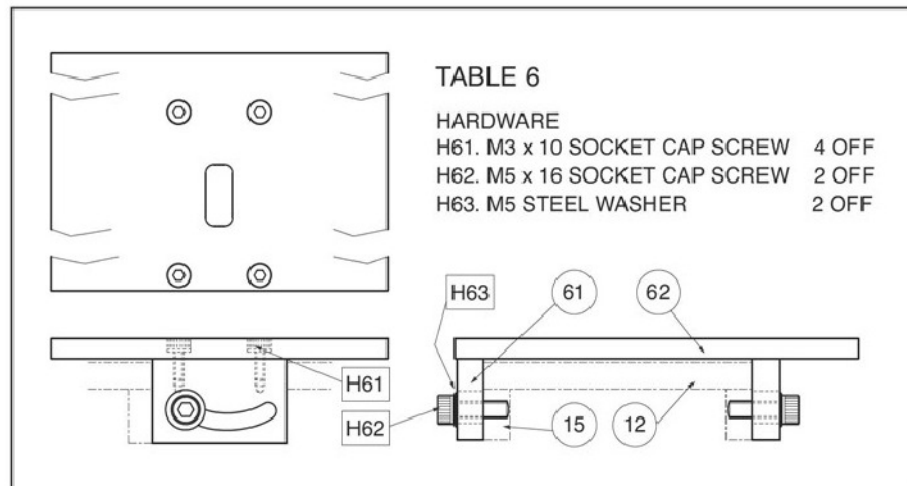
22. The Table Assembly (6)

Having positioned the rotary table on centre, place the locating fence on it and lower the centre into this, **photo 24**, and clamp it in position. This ensures that the centre mark on the fence is concentric with the rotary table. Now add the workpiece to the rotary table with it up against fence and the right hand end aligned with the end of the fence, and clamp in position. However, to avoid the cutter breaking through and damaging the rotary table place a piece of thick card, between the workpiece and the table. Do also set the down feed stop to avoid an accident by a momentary loss of concentration.

Unlock the milling machine's X axis and traverse the table back through a distance of 24.5mm to set the radius required. Lock the table in the X axis once more. With a 5mm slot drill in the machine, rotate the table until it aligns with one of the machine-to lines and mark the table's calibration at that point, similarly for the other end of the slot. Unfortunately, rotary tables rarely have adjustable stops so marking the table is the only option. Make the slot by repeatedly traversing



23. Centring the rotary table below the milling machine spindle.





24. Centring the locating fence on the rotary table.

backwards and forwards, increasing the depth at each pass. **Photograph 25** shows that the first table pivot has already been completed.

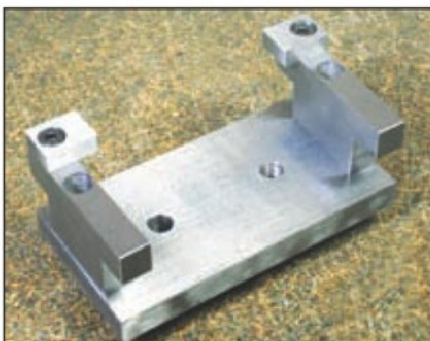
Table (62)

This is a simple part but I have included **photo 26**, which shows my setup for milling the rectangular cut out required. Note how the packing that allows the cutter to break through to complete the cut out is inherent in the clamping method. I also used my X and Y table stops to fix the cut out size making the process a very easy one as it did for the top plate (12) which has a similar cut out. Next, set up the table in a tilting vice and machine the angle on the underside of the cut out, **photo 27**, the purpose of which is to permit the table to be set at an angle.

Lathe mounting assembly (7)

The GA of this assembly was given in MEW issue 161. It is obviously impossible to establish a method of mounting that will satisfy every situation and I am therefore detailing the method I used for my Myford Series Seven. No doubt a similar arrangement would suffice for any flat bed machine and be a basis for other bed forms.

Many readers will be conversant with the problem of securing items to the lathe bed where a clamping plate has to be held below the bed shears, the device being fitted held in position above the bed and the fixing screws put in place and fastened. This is certainly a case where a third hand,



28. The Myford Series Seven mounting locating assembly.



25. Making the curved slot in the Table Pivot. Note that the part is against the fence and level with its end ensuring the slot will be the required diameter and in the correct position.

would be an advantage, and even then ending up with oily hands from the bed. I decided therefore that I would like a system that would be much easier and if I may say this I feel that I have achieved that.

The assembly, **photo 28**, is a very simple item comprising just three parts, all of which need no comments regarding their manufacture. A brief comment on how the mounting assembly works is though appropriate as it is not obvious from the drawings or photographs. The two side members are not held firm by their fixing screw but are free to rotate. In use, they are first pivoted to be at 90deg. compared to that shown by the photograph, this enabling the clamp plate to be tilted so as to position it below the bed shears, with that done they are returned to the position shown where they then just sit in place waiting the arrival of the filing machine.

Photograph 28 shows that the sides have ears, the purpose of which is to retain the filling machine after it has been put in place until the fixing screws are collected and fitted, it could not be simpler, the finished result being shown in **photo 29**. Putting on the belt tension would benefit from being made simpler but I decided that this would necessitate undue complication.

The reader may though be interested in my method of adding the slots in the machine base, **photo 30**, as this uses my recently made high profile clamps to secure the part whilst the slots are being machined. The details of these clamps are elsewhere in this magazine.

Drive spindle pulley (73)

I have not given a size for this as it is dependant on many factors but the following details of the speeds I have used should help the reader to choose a suitable diameter for his or her situation.

Quite mistakenly, I originally felt that I may need a speed that would take me into



29. The filing machine secured to a Myford Series Seven.



26. Machining the slot in the table. See the method of clamping, which raises the part off the table, enabling the cutter to break through.



27. Machining the bevel on the slot that enables the table to be tilted to 45deg. without the need for a larger cut out.

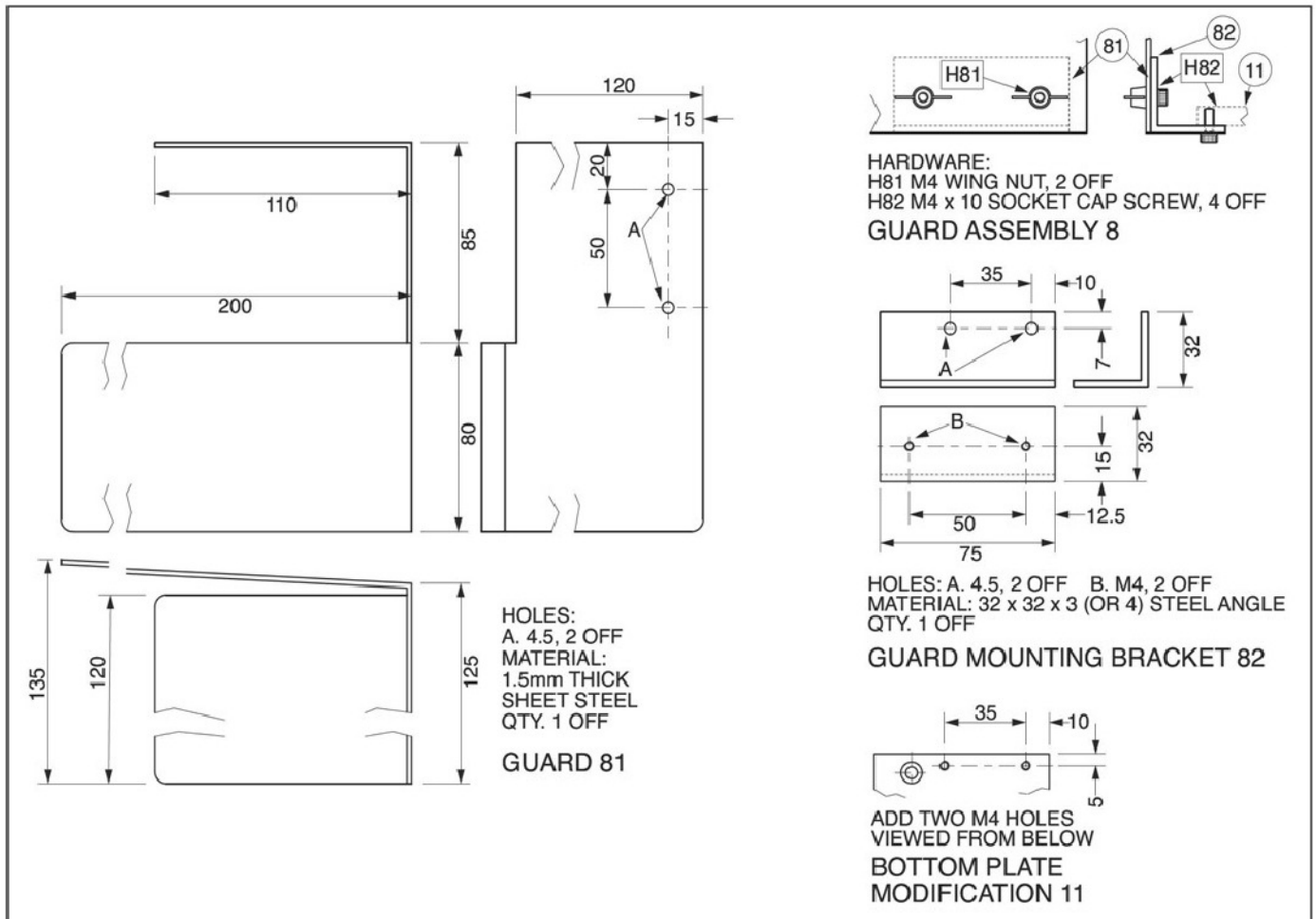
the back gear range of my lathe and to minimise this possibility I chose to include a step down ratio in the belt drive so as to keep the lathe speed as high as possible. Therefore, I chose a 40mm pulley on the lathe with one 60mm on the machine.

I initially started by running the machine at speeds of around 150 strokes per minute finding this very easy going for the machine but obviously too slow for a reasonable rate of material removal. I upped the speed in stages and found the following. At 400 SPM the machine ran very smoothly and was still smooth at 700SPM. When going up to 1000SPM vibration was becoming a factor though far from dangerously so, but I would not use it at this speed.

Rather than being in the back gear speed ranges, I had moved into the top range of speeds where the countershaft was at its highest speed. Therefore, instead of my step down belt ratio, the reverse would



30. Machining the slots in the filing machine bottom plate.



obviously be worthwhile but as I do not have any aluminium larger than 60mm diameter I will stay with what I have as it is not crucial.

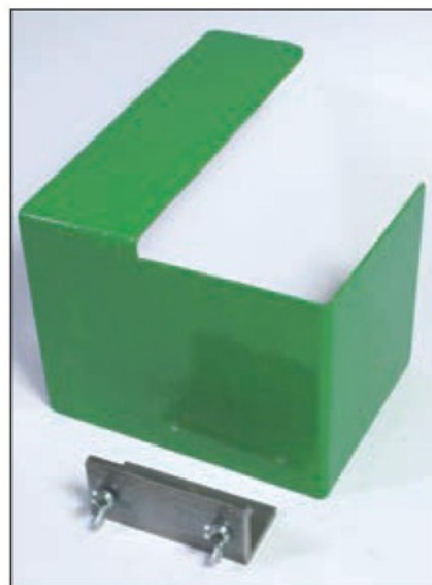
Guard Assembly (8)

Some may consider it unnecessary to fit a guard to the machine and that is a decision the reader must take responsibility for. Personally, I consider that one is an essential requirement. If you see the mechanism running at some 700 strokes per minute you will soon realise the potential danger, even if used with care. Therefore, I consider that the reader should fit the guard shown in **photo 31** and fitted in **photo 32**. Note that it is secured with wing nuts that enable it to be removed and fitted with ease, which is necessary to change and align the files. Since making the guard I have increased the height of the guard on the drawings to increase the level of protection. Note that the fitting arrangement requires two extra holes in the bottom plate (11).

Files

Adaptors are fitted to the files as shown in **photo 33** enabling them to be easily fitted to the filing machine and whilst there are just two types, one having a slot to accept flat files and the other with just a hole for round square and triangular files, the size of the slot or hole will have to be chosen to suit the file being fitted. Also, some shaping of the end of the file where it enters the adaptor is suggested, see **Sk. 2**.

Each file will need to be positioned in the adaptor with some care so as to ensure that, with the limited adjustment available



31. The filing machine guard.

on the machine, it can be set to be parallel with the file's movement. **Photograph 34** shows how the round file is being held in position on the lathe whilst the two-part resin adhesive being used is setting. Other shapes will have to be held on the end of the tang, which may be marginally less accurate but should still be sufficient.

When applying the adhesive, do not just place it in the hole and then press in the file as air pockets are likely to be trapped in the individual teeth reducing the strength of the final bond. Do therefore smear a very light coating of adhesive over the file's teeth prior to placing it.



32. The guard fitted to the machine.

Using the supporting method illustrated in **photo 34** will of course only allow one file to be fixed at a time.

Once the file is fixed in the adaptor then the tang can be removed using an angle grinder fitted with a thin disk. Failing that the workshop offhand grinder can be used. Finally, generally tidy up the end of the file.

Assembly

Assembly is very straight forward with only three areas being marginally important. First, assemble the main frame (1) temporarily adding the drive



33. Six 100mm files fitted with adapters.



34. This method of locating the file whilst the adhesive sets ensure that it will be accurately positioned.

spindle carrier (22) so as to ensure the tapped holes in the posts (13) are correctly positioned. Leave the screws fixing the two left hand posts loose and use the two 19mm diameter ball races, one at either end, to set the spacing of these using the clearance in the holes to enable the adjustment to be made, then secure.

The only other area that needs special attention is the oscillating assembly (3) Place a piece of the 16mm diameter ground bar through the two slider blocks (34) and assemble fully with the exception of the ball race. If you do not have a spare piece of ground bar, remove the post from the main frame and use that. In any case you will have to remove this eventually to fit the oscillating assembly.

Check that the bar will move through the two slider blocks even with a hefty push. If not, then like me you will need to do a bit of fitting. Remove one of the blocks and re-tighten the other screws. Slide the loose block onto the bar and observe the result, if it fouls the plate and will not go into position it indicates that the hole in this is too high. If though it moves freely into position the hole in the other block is too high. Having made these tests they can be repeated with the other block loose to check that you come up with the same conclusion.

In my case, having decided which needed metal removed, I placed a piece of 240 grit emery paper on a flat surface and rubbed the block back and forward no more than ten times, to my surprise, when assembled the bar could be slid through the blocks, albeit quite stiffly.

With that resolved (if you have to) but with the bar still in the blocks, again whilst loosely fitted, set the spacing of the upper and lower plates (36/37) using the two 19mm diameter ball races to establish the distance.

The remaining areas can be fully assembled and then fixed to the lathe when it should be run at a slow speed, say 200 strokes per minute to run it in. In my case the mechanism was quite stiff initially, albeit I could operate it by hand, but after about two minutes running it could be turned freely. It was then that

turning it by hand I noticed the slight knocking as the ball race passed the through hole in the left hand post, and as mentioned earlier this was cured by plugging the hole, the drawings now call for blind holes.

Saws

Having found that the machine worked at much higher speeds than I originally thought it occurred to me that using it as a vertical hacksaw would also be a possibility so I made adaptors for fitting a fine tooth junior hacksaw blade so as to try out the idea. See Sk. 3 for the fitting method I adopted.

Tensioning the blade seemed likely to be a problem but to carry out the initial tests, with the minimum of additional items, I chose to leave the two screws that secure the upper file support (42) loose so that the outer end dropped slightly, say just 1mm. With the saw in place these screws were tightened thereby tensioning the blade.

In use it coped quite well with 2mm thick steel and 3mm thick aluminium, however, it did occasionally grab the workpiece on the up stroke lifting it from the table which

was disconcerting. I need to do further tests probably using a little lubrication on the saw blade. At this stage, I would be hesitant to use it for other than quite large parts as I do not fancy getting my fingers too near the saw blade. A miniature pusher, as one would use at a larger size when feeding timber through the bandsaw or planer would perhaps make the task more viable.

At this stage I feel the user should attempt this use of the machine with considerable care. However, it needs very little by way of special items to be made so if found unacceptable very little wasted time will result. Abra files could be mounted similarly using a round hole to accept them rather than the slot but I have not tried this.

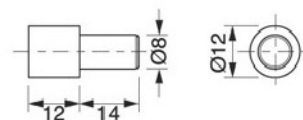
Having completed the machine and run it, I am more than happy with the result and the lack of any major problems leading up to that point. A very minor point is that I had designed the table to tilt to 45deg, which it does. However, the one part of the machine that I designed on the job was the file adaptors and as a result overlooked that these would foul the underside of the table in the 45deg. position. This can be overcome by machining a slope on the front edge of the adaptor or machining a recess on the underside of the table. The easiest way out though is to run the machine at a slightly reduced stroke length.

I am sure that many readers will find this machine an interesting project whilst others may wish to limit the work involved. With that in mind there are two areas where the machine can be simplified quite significantly but both eliminating the most interesting parts of the manufacturing process.

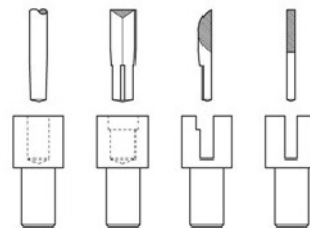
The variable stroke mechanism (5) as seen in photo 19 could be replaced with a single disk of steel having holes at different distances from the centre enabling the ball race position to be modified and thereby the stroke length. Do note though that there is no room above the ball race for the head of a fixing screw so the screw would have to be fitted from the rear and with counterbored holes. The major disadvantage of this suggestion is that the machine would then need to be partially dismantled to permit the adjustment to be made. As the design is presented adjusting the stroke length is very easy.

The other potential simplification is to mount the variable stroke mechanism onto a mandrel that is mounted directly into the 3-jaw chuck eliminating the input drive spindle (2). This would necessitate the machine being packed up on the lathe bed or the posts increased in length. If this method was employed then the simplified variable stroke mechanism would be a more practical proposition. For me, the disadvantage of the arrangement is that it moves the machine back over the bed and into a less comfortable operating position. Incidentally, the input drive spindle is included in the design as it is an essential item if the machine is belt driven from a separate motor.

Can I remind the reader that if they of she would like to see more pictures including some close-ups of the mechanism, then go to my website www.homeweb.co.uk/page9.html and click on the link "further projects". To be continued...



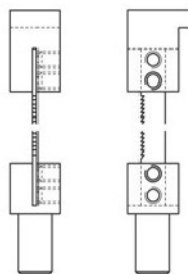
MATERIAL: 12 DIA. STEEL 230M07
QTY. 1 PER FILE
BASIC FILE ADAPTER



NOTES:

1. REMOVE THE CORNERS OF A TRIANGULAR FILE FOR A DISTANCE OF 8mm TO CREATE A HEXAGON
2. MAKE A FLAT 8mm LONG ON THE CURVED SURFACE OF A HALF ROUND FILE.
3. WHERE THE END OF A FILE IS MODIFIED, SHAPE THE CAVITY IN THE ADAPTOR SO THAT FULL SHAPE CAN ENTER FOR A FEW MILLIMETRES.
4. SQUARE FILES CAN ENTER A ROUND HOLE, OR BE MODIFIED IN A SIMILAR MANNER TO THE TRIANGULAR FILE

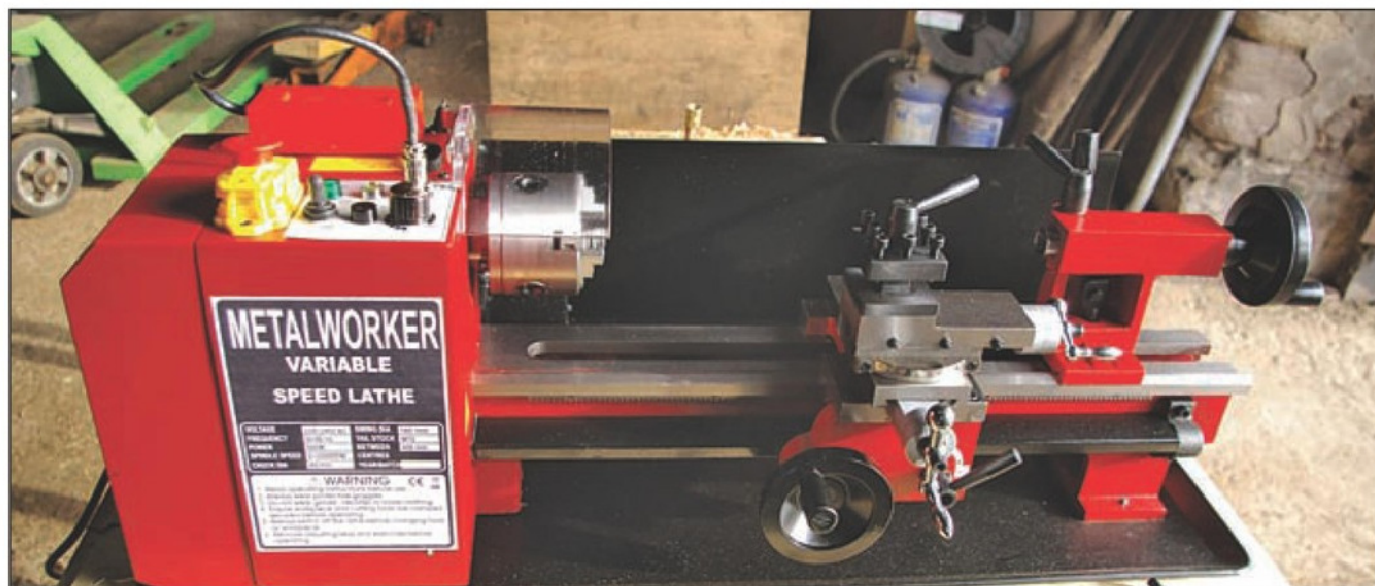
FILE MOUNTING METHODS SK. 2



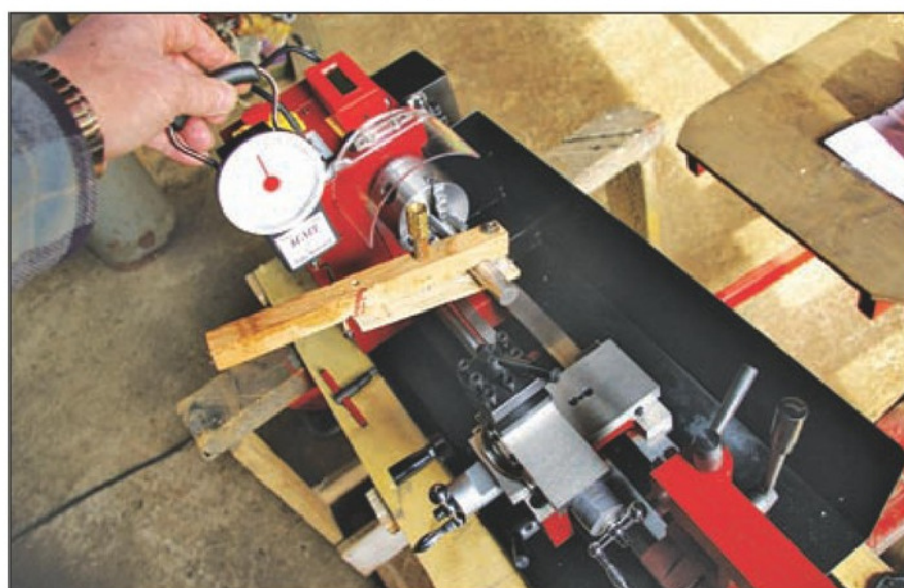
SUGGESTED METHOD OF FITTING A SAW BLADE TO THE MACHINE.
DO SEE THE COMMENTS IN THE TEXT REGARDING USING IT IN THIS WAY.
SAW BLADE MOUNTING SK. 3

AN IMPROVED MINI LATHE FROM SIEG

Dave Fenner
tries out this
updated
popular lathe



1. New Mini Lathe. The main visible changes are the control panel and leadscrew guard.



2. Heath Robinson torque measurement using wooden clamp brake and hanging scale.



3. Depth of cut here is 2.3mm.

OVERVIEW

Never a firm to rest on their laurels, Sieg have raised their game with a revised version of this popular little lathe (photo 1). Probably the most significant, although not the most obvious change is the motor where the DC brushed motor has now been replaced with a brushless type.

This type of motor has become very popular in aeromodelling circles where the advantage of high power in a small package is particularly relevant.

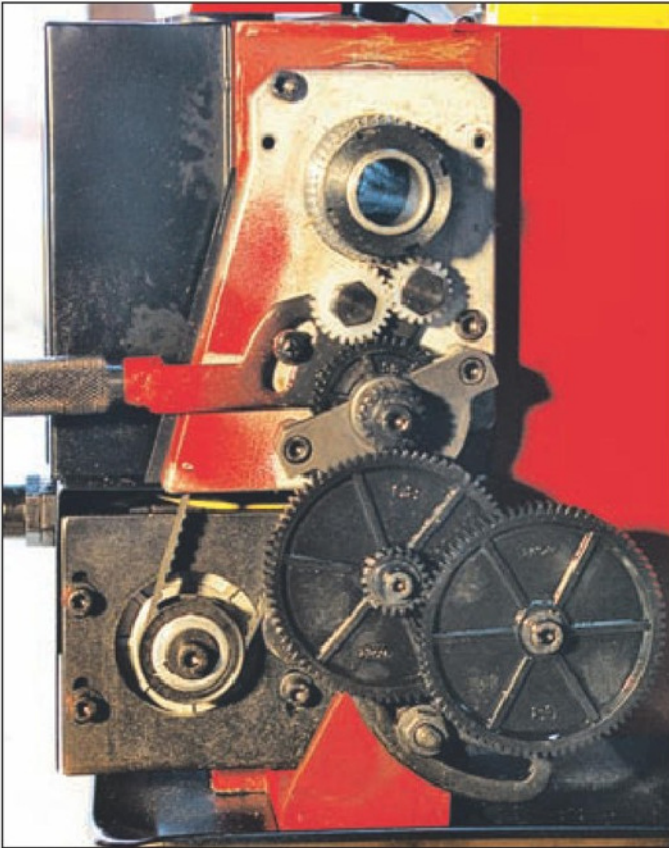
As with the earlier C3 lathe, this is a machine that Arc Euro Trade will be selling either "Factory Assembled" or "Arc Prepared". This policy acknowledges that while these machines will function adequately "out of the box", the performance can be substantially improved by a careful strip down and rebuild/readjustment exercise. Details of the suggested work can be found by referring to the sources given in the 'Resource Box' at the end of this article.

General

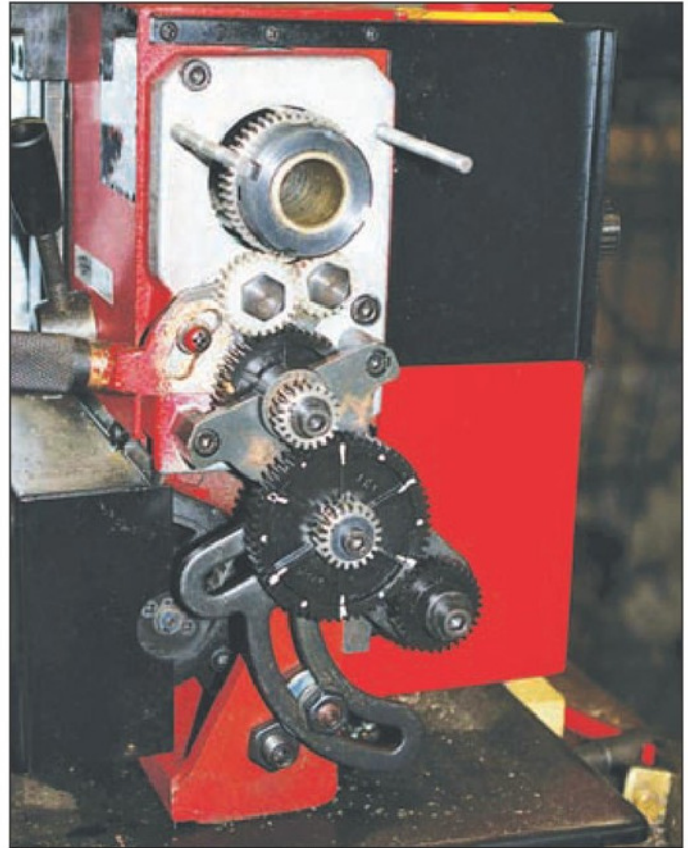
Looking at the data plates on the old and new machines gives a flavour of the changes. The motor power has increased from 350watts to 500 watts (i.e. it's now about $\frac{3}{4}$ hp) and the between centres dimension has increased by 50mm to 400mm.

Headstock

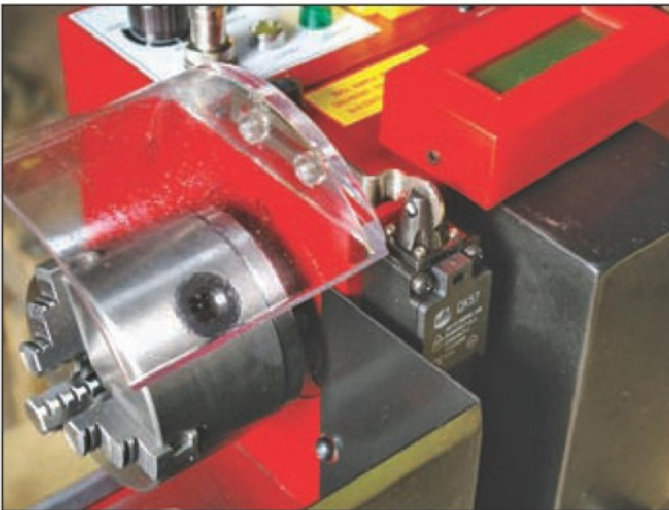
Apart from the leadscrew guard, the noticeable changes are all in the headstock area. Because the motor is controllable from a high speed (about



4. On the new machine, the belt drive is directly from motor to spindle....



5.whereas on the old, the drive is taken to a countershaft with two speed gear selection.



6. The new chuck guard hinge and safety switch. Also visible is the tachometer speed read out.



7. The older style chuck guard hinge and safety switch.

2500 rpm) down to a very low speed, (about 50 rpm) the high/low speed gear change is no longer necessary. My first thought was that this might compromise the machine's ability to remove metal, particularly at low rpm. As a rough and ready means of investigating this, I rigged up the torque measuring arrangement which can be seen in **photo 2**. On the original Mini-Lathe, running at about 250rpm in low gear, I could wind up the adjuster nut until the overload tripped with the scale showing about 3 Kg. The revs dropped by about 40rpm just prior to tripping.

On the new machine, at the same speed, it had not tripped at over 4 Kg and at this stage the torque brake was getting seriously hot and I chickened out. Interestingly, the revs did not seem

to drop although the motor sound did change suggesting that the system was working harder. In general the new machine runs more smoothly and quietly, probably because it no longer uses gears in the power transmission to the spindle. **Photo 3** shows a rudimentary test using a piece of 22mm mild steel. After adjusting the topslide, it was possible to take a cut of 0.090in. (2.3mm) without chatter.

Photograph 4 showing the new change gear train may be compared with **photo 5** showing the old version. Slight changes have been made to the light alloy casting and also to the gear cover. The drive is now direct from the motor to the spindle, since the two-speed countershaft is no longer present. Another small change concerns the

chuck guard safety switch; **photo 6** shows the new switch and **photo 7** shows the old version.

Regarding the electrical controls, the old machine had a built in tachometer readout. On the new, this feature is an optional extra, which plugs in and can be attached by magnets to the top of the headstock, as shown in **photo 8**.

Motor speed is controlled by a rotary knob that is marked between zero and 2500rpm and it is likely that this would allow sufficiently accurate speed selection for most purposes. Those wishing for higher precision in speed control can simply plug in the readout.

Having fitted the tachometer set, it was possible to set the knob against the line graduations and compare with actual revs. The following readings were noted:



8. The new style control panel with add on speed read out.



9. Full length guard to keep swarf, fingers and loose clothing from contacting the leadscrew.

Knob setting	Tacho readout
100	0
200	90
300	270
400	410
500	580
1000	1020
1500	1560
2000	2080
2500	2490

One very visible change is the inclusion of a guard for the leadscrew (photo 9). Apparently this is now a Health and Safety requirement for some markets. On the plus side, the guarding certainly keeps swarf from becoming lodged in the leadscrew thread; on the minus side it causes a change from two clasp nuts to a one clasp half nut system. I have not been able to

confirm this point, but it looks possible to modify the new machine to "old status" by removing the guard and adding the second half nut. Assuming this to be correct then for owners who prefer the old "two half nut" arrangement, it is likely that the spare parts to retro fit this will in due course be offered by Arc Euro Trade.

Summary

All in all the Mini-Lathe has now acquired some serious grunt. For the older machine, the makers claimed a lowest speed of 100 rpm. For the new, the practical bottom of the range is probably about 60 to 70 rpm. If you go to look at one of these little machines, remember it now has a $\frac{3}{4}$ hp motor (many Myford's have $\frac{1}{2}$ hp) so do not be tempted to try holding the chuck to stall the motor; it now has real bite. ■

MEW RESOURCE BOX

Details of the procedure for dismantling - improving - rebuilding and readjusting the Mini-Lathe may be found in /on:

- Arc Euro Trade website www.arceurotrade.co.uk
- Model Engineers' Workshop Issue number 133
- The Mini-Lathe (Workshop Practice series No 43) available from www.myhobbystore.co.uk



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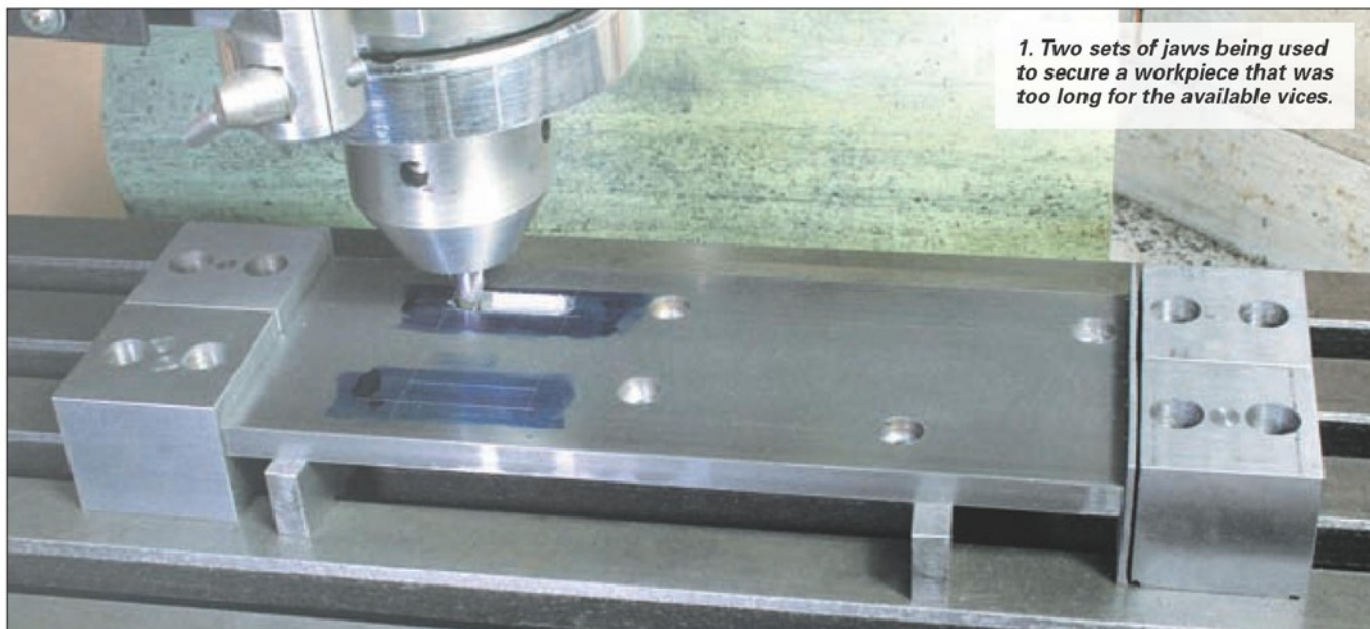
Before ordering, measure the height from the tool-rest landing to the lathe centre. This is directly related to "Dim X" which is the minimum setting of the tool bit in the holder. The tool can be packed up to suit higher centre heights. Select the type that suits your application.



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Type	L.W.H.	Dim X	Tool Bit Size	PRICE
T6 (Mini Lathes, Sieg)	52 x 9.5 x 9.5mm	6mm (1/4")	1/8" Square	£ 54.00
A8 (Myford)	77 x 12 x 11mm	8mm (5/16")	1/4" Square	£ 67.00
A9.5 (Southbend)	77 x 12 x 13mm	9.5mm (3/8")	1/4" Square	£ 67.00
B16 (Colchester)	77 x 14.3 x 15mm	16mm (5/8")	1/4" Square	£ 69.00

Price includes UK postage.



HIGH PROFILE CLAMPS

Harold Hall describes another useful type of clamp

For the original clamp, the working face was just 14.5 mm wide being governed by the width of the tee slot in which it was to be used, 15mm in my case. However, when I eventually came to consider the idea, I came to the conclusion that making it wider, whilst still using the same clamping method, would result in a more useful clamp. For that reason it could no longer

be just a single piece of steel and the device is now held in position by using a separate tee nut having two, rather than one, fixing screws. The reason for using a two screw fixing is that the method will be capable of a considerable clamping force that will be attempting to move the clamp along the worktable. With that in mind it is worth taking note of the fact that the device uses four 1mm pitch clamping

OVERVIEW

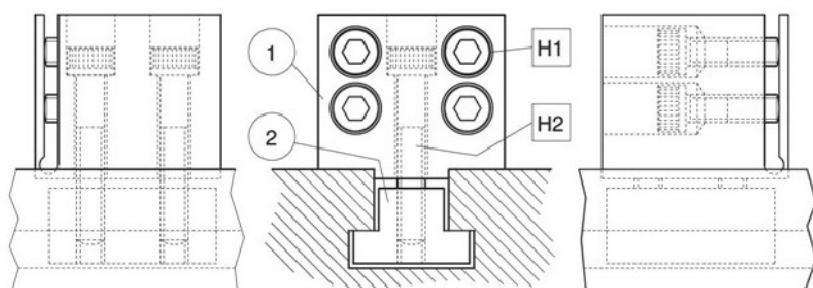
I have used the term "High Profile Clamps" for the devices that feature in this article because they were born out of the low profile clamps that I made and provided an article for that was published in MEW (ref 1). The article offered five forms of clamps, four being of two piece construction, that is a fixed portion and a moving jaw and the fifth was just a single piece of steel. At the time, I remember thinking that the height of this last one could easily be increased for holding more substantial workpieces.

screws. This compares to a single screw of 3 or 4mm pitch on the average vice so that a secure hold will be achieved with much less torque being applied.

Whilst a single fixed jaw with a single clamping jaw will find many uses in the workshop, making two pairs will greatly enhance the capability of the system.

Photograph 1 shows two sets of clamps being used to secure a length of steel whilst a pair of slots is being cut in it. The advantage of the system in this case was that the workpiece was far longer than the vices available would handle and it was quicker and easier than setting it up using conventional workpiece clamps.

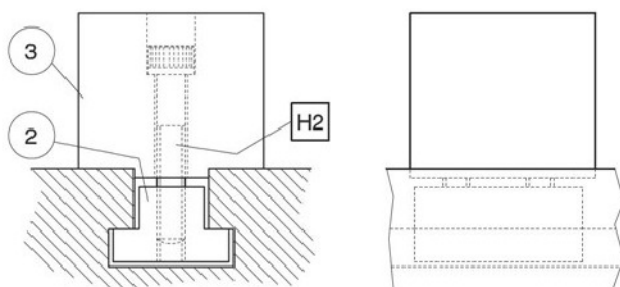
The drawings show the clamps as I made them, with one exception which I will discuss later. The reader may have to amend the clamp dimensions to suit the milling machine on which they are to be used. Even if the dimensions given suit the tee slots on your machine, do check that two sets can be mounted in adjacent slots. If not, then modify the width to permit this, see photo 1, which illustrates this requirement. Of course, you may choose to make only a single pair of clamps should you consider this to satisfy your requirements.



HARDWARE: H1 M6 x 20 SOCKET CAP SCREW, 4 OFF

H2 M6 x 35 SOCKET CAP SCREW, 2 OFF

CLAMP JAW ASSEMBLY



HARDWARE: H2 M6 x 35 SOCKET CAP SCREW, 2 OFF

FIXED JAW ASSEMBLY

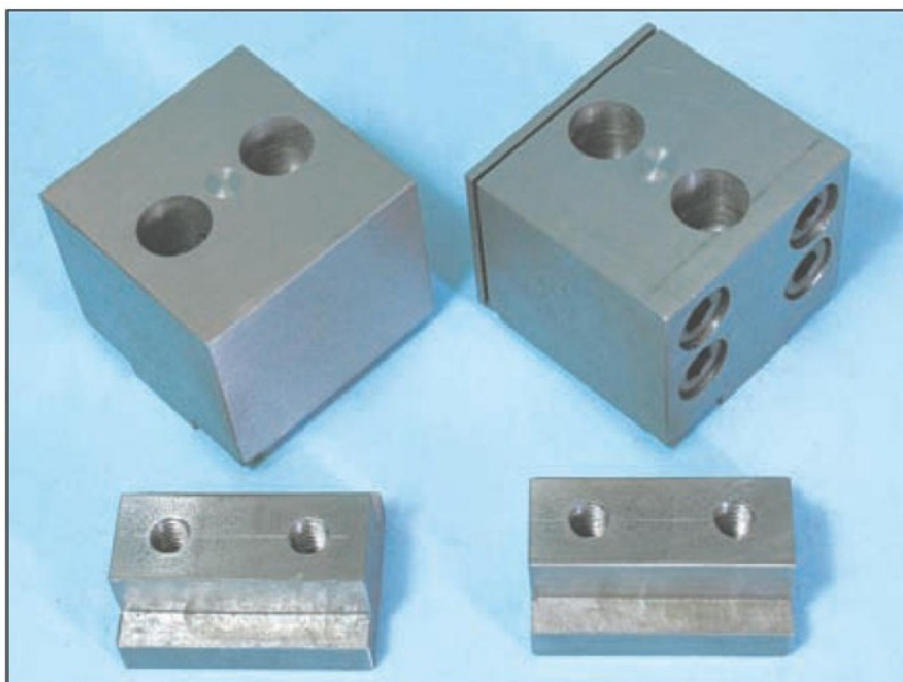
Fig. 1



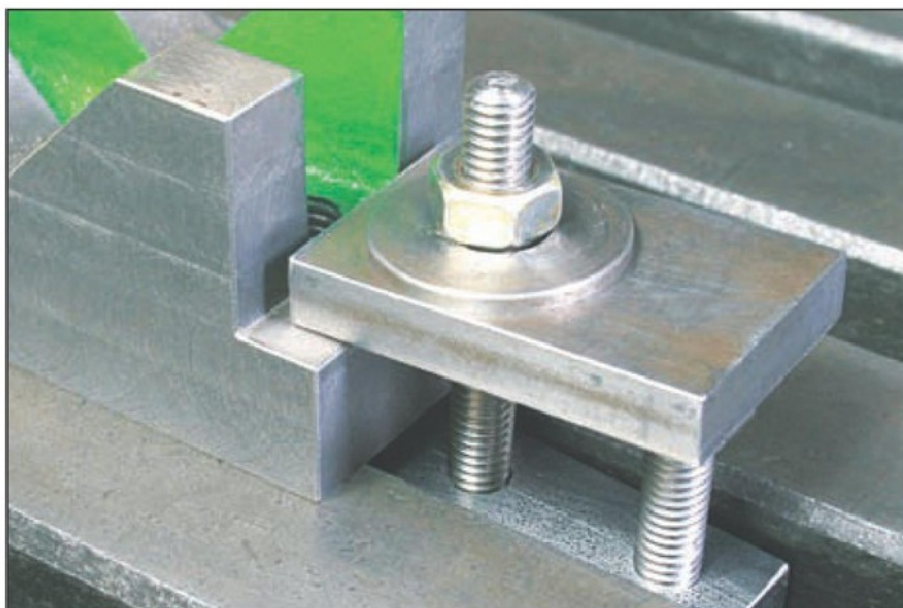
2. One of the tee nuts being machined



3. Counterboring the jaw's fixing holes.



4. A single set of finished jaws.



5. The Tee nut alone can be used with a jacking screw as a method of securing small workpieces.

Manufacture

This is very straightforward, but having said that, I managed to make a hash of one aspect of it. That was when machining the slots, an operation that I have frequently ended up less than satisfied with. Originally, I used to run the slitting saw at too high a speed. This is easily done as it cuts well, but having very little mass it rapidly overheats and the teeth are destroyed. Having learnt that lesson, I still had problems with the saw running off course if I was attempting a deep cut. I did wonder that as the milling machine spindle was not perfectly upright (ref 2) compared to the workpiece traverse, the saw as a result would be very slightly out of line with the groove it was attempting to cut; did this result in the saw deflecting and the cut going off course? Do any readers have any experience of this problem and its reasons?

I did though make a decision some time back, as was evident from the slots in my "Four jaw alternative chuck" jaws, (ref. 3) always to make wider slots wherever possible but seem to have forgotten this. I tell you this tale of woe only to explain why the grooves in the jaws in the photographs do not tally with those I detail on the drawings, which I have increased in width in an attempt to minimise the problem for the reader.

Being so simple to make, slots excepted, I do not intend to go into detail but will publish a couple of photographs. **Photograph 2** shows a Tee nut being machined and whilst I do not normally go into details of speed and feed rates the reader may be interested. The cut is 4.5mm deep by 9mm wide and is being taken with a relatively new cutter of 20mm diameter running at about 350rpm and there seemed plenty in hand. Whilst not very evident from the photograph the vice is one of the very cheap lightweight drilling vices that I have modified with a longer moving jaw and keep plate. When I am quizzed regarding using such a lightweight vice, I point out that it is low slung, a definite advantage both to the slides of the

machine and to the vice itself, and equally important it has four widely spaced fixings and inherits considerable strength from the table itself.

Photograph 3 shows the jaws being counterbored using commercial counterbores but for years I used my own versions made from silver steel. Whilst these worked reasonably well the commercial cutters make the task very easy. If you do not have a suitable counterbore do not under any circumstances attempt to get by using just a drill, especially for these jaws where security on the machine table is of paramount importance. **Photograph 4** shows one of the two sets of jaws that I made.

A by product

A feature of this set of jaws, not originally envisaged, is that if the double tapped Tee nuts are used with a jacking screw in one hole and a fixing stud in the other they provide quite a simple method of securing small items to the worktable (photo 5). ■

■ MEW RESOURCE BOX

1. Low Profile Workpiece Clamps MEW issue 118 page 12.
2. Know Your Mill. MEW issue 143 page 12.
3. Four Jaw Chuck Alternative. MEW issue 157 page 12.

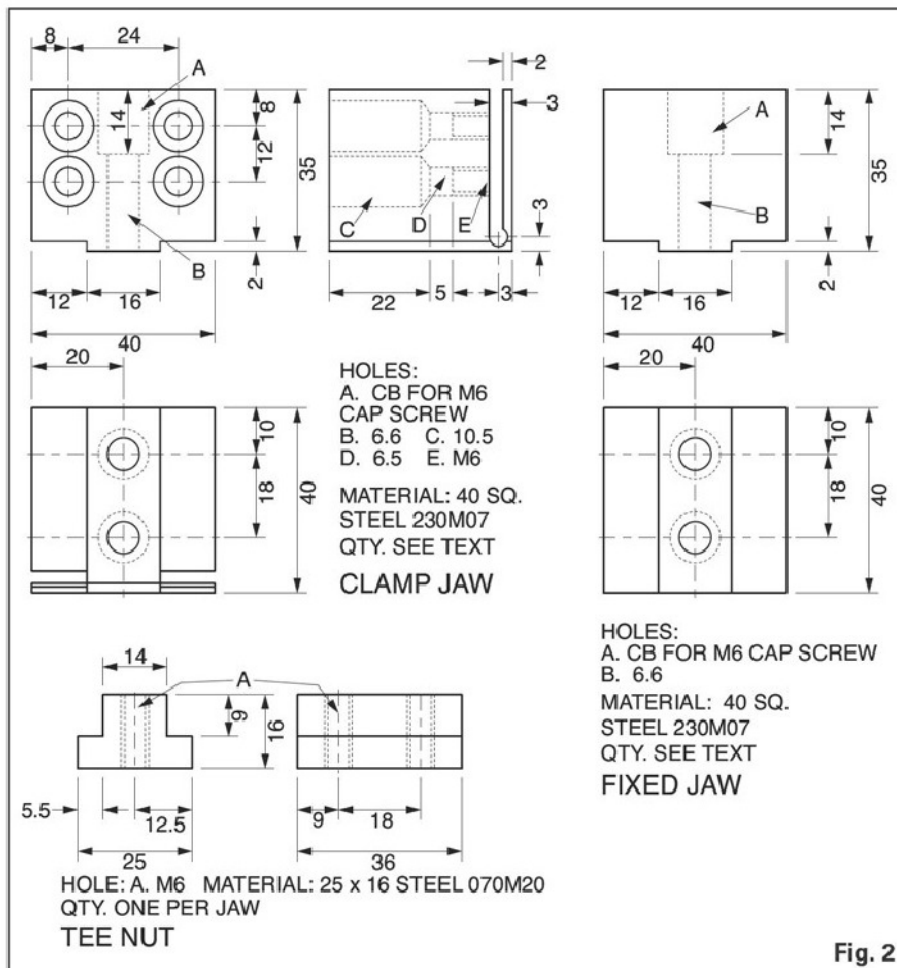


Fig. 2

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Boxford 160 TOL CNC Bench Lathe with Indexable Turret	E950.00 +VAT	7524		Taylor Hobson Pantograph Engraver	E75.00 +VAT	7300		Elliott Progress No 1 Bench Drill	E75.00 +VAT	1139
Boxford 160TOL CNC Bench Lathe with Indexable Turret, 1ph	E675.00 +VAT	7532		Tom Senior M1 Horizontal/Vertical Mill, 3ph	E750.00 +VAT	7492		Elliott Progress Pillar Drilling Machine	E75.00 +VAT	7340
Boxford 5 inch x 22 inch GUD Lathe, 3ph	E650.00 +VAT	7490		Tom Senior M1 Horizontal/Vertical Milling Machine with Phase Converter	E995.00 +VAT	7560		Elliott Progress Pillar Drilling Machine	E100.00 +VAT	7330
Boxford Model A Lathe with Stand, Gearbox & PCF, 1ph	E1000.00 +VAT	7515						Elliott Progress Pillar Drilling Machine	E75.00 +VAT	7338
Clarke 300mm Variable Speed Lathe, 1ph	E350.00 +VAT	7537						Fobco Star 1/2 Cap. Bench Drill	E175.00 +VAT	7387
Colchester Bantam 800 Lathe with Tooling, 3ph	E725.00 +VAT	7528						G & M Multi Drill Head	E125.00 +VAT	2069
Denford Startum PC CNC Bench Lathe, Indexable Turret, 1ph	E875.00 +VAT	7516						Meddings Articulated Arm Drilling Machine, 3ph	E950.00 +VAT	7542
Myford ML7 Lathe on Cabinet Stand with Gearbox	E750.00 +VAT	7423						Meddings LFPS Pillar Drill	E375.00 +VAT	6643
Myford ML7R Lathe with Gearbox	E1600.00 +VAT	5976						Pollard Bank of 4 Drills, 3ph	E150.00 +VAT	7476
Peatol Bench Lathe, 1ph	E350.00 +VAT	7538						Small Bench Sensitive Drill with 240 Volt Motor	E125.00 +VAT	6833
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Schaublin 102 Lathe, Stand, Tooling, 3ph	E4500.00 +VAT	7449								
Simat 101 Bench Lathe, 1ph	E350.00 +VAT	7536								
Smart & Brown 1024 Toolroom Lathe, Tooling, 3ph	E1600.00 +VAT	7541								
Warco TY 1125B Lathe with Stand, Tooling, 1ph	E850.00 +VAT	7502								
Milling Machines, Engravers, Jig Bore		Item Code		Grinders, Polishers, Linishers		Item Code		Boxford spares and Tooling		Item Code
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Alexander 3A Die Sinker/Engraver	E950.00 +VAT	7282		Canning Double Ended 4 HP Pedestal Buffer, 3ph	E275.00 +VAT	7513		Boxford 4 inch Cast Iron Chuck Backplates	E22.00 +VAT	7236
Boxford 190VMC Vertical CNC Bench Milling Machine, 1ph	E950.00 +VAT	7525		Canning Double Ended 5 HP Pedestal Buffer, 3ph	E300.00 +VAT	7514		Boxford 5 inch Catchplate	E15.00 +VAT	124
Boxford 190VMC Vertical CNC Bench Milling Machine, 1ph	E850.00 +VAT	7533		Denford Viceroy Double Ended Buffer on Pedestal Stand	E75.00 +VAT	7319		Boxford 5 inch Tailstock	E125.00 +VAT	5101
Boxford 250 VMV CNC Vertical Milling Machine, 1ph	E1000.00 +VAT	7493		Denford Viceroy Pedestal Buffer/Grinder	E175.00 +VAT	6419		Boxford Boring Table	E135.00 +VAT	7519
Boxford 250 VMV CNC Vertical Milling Machine, 1ph	E1000.00 +VAT	7531		Double Ended Pedestal Buffer	E65.00 +VAT	7307		Boxford Cabinet Stand with Coolant Tank	E100.00 +VAT	6261
Bridgeport Variable Speed Turret Mill, with Power Feed Table, 3ph	E1250.00 +VAT	7539		Eagle Hand Operated Surface Grinder, 3 phase	E550.00 +VAT	7475		Boxford Change Gear Cover	E40.00 +VAT	131
Centric 28 Vertical/Horizontal Milling Machine, 1ph	E1100.00 +VAT	7561		Jones & Shipman 540 Surface Grinder	E750.00 +VAT	7285		Boxford Change Gear Quadrant	E15.00 +VAT	132
David Dowleng Bench Pantograph Engraving Machine, 1ph	E450.00 +VAT	7544		RJH Buffalo Double Ended Buffer	E350.00 +VAT	6987		Boxford Change Gears	E +VAT	120
Denford Novamill CNC Vertical Bench Mill, 1ph	E450.00 +VAT	7499		Suretech Pedestal Backsaddle Linisher	E650.00 +VAT	6418		Boxford Coolant Pumps from Boxford Lathes	E40.00 +VAT	6262
Elliott UO Universal Milling machine with Swivel Table	E1650.00 +VAT	7540		Vanco 1 inch Vertical Bench Linisher, 1ph	E250.00 +VAT	7558		Boxford Lathe Spindle	E75.00 +VAT	3901
Dividing head & Vice, 3ph				Viceroy Double Ended Polisher	E225.00 +VAT	6974		Boxford Metric Cross Slide Nut, Used	E30.00 +VAT	7385
Harrison Vertical Milling Machine, 3ph	E725.00 +VAT	7529		Vision Universal Grinder on Cabinet Stand, Tooling, 1ph	E950.00 +VAT	7510		Boxford Metric Cross Slide Screw for AUD or BUD	E35.00 +VAT	7391
Sentinel Milling Machine	E1250.00 +VAT	7283		Wolf Double Ended Pedestal Polisher	E50.00 +VAT	7402		Boxford Motor Drive Unit and Countershaft	E65.00 +VAT	6264
Taylor Hobson Bench Pantograph Engraving Machine, 1ph	E475.00 +VAT	7545						Boxford Power Crossfeed Saddle Assembly	E250.00 +VAT	136
Hacksaws, Cut Off Saws, Bandsaws		Item Code		Drilling & Tapping Machines		Item Code		Boxford Pulley & Plummer Block Drive Unit	E35.00 +VAT	7121
6 inch Capacity Power Hacksaw, 3ph	E275.00 +VAT	7357		Bench Tapping Machine with Single Phase Motor	E200.00 +VAT	7123		Boxford T Slotted Cross Slide with One T Slot	E65.00 +VAT	7382
Ajax Heavy Duty Power Hacksaw, 1ph	E275.00 +VAT	7501		Denford Viceroy Pillar Drilling Machine	E48.00 +VAT	7328		Boxford Topslide for 5 inch Lathe, Metric	E75.00 +VAT	7249
Quattri & Smith 6 inch Power Hacksaw, 3ph	E275.00 +VAT	7562		Drill Vice	E20.00 +VAT	7017		Boxford TUD Headstock	E75.00 +VAT	5417
Rapido Manchester Power Hacksaw, 3ph	E225.00 +VAT	7049		Elliott Pillar Drilling Machine	E100.00 +VAT	7327		Pratt Burnerd 6 inch 4 Jaw Independent Chuck, Very Good condition	E125.00 +VAT	7563

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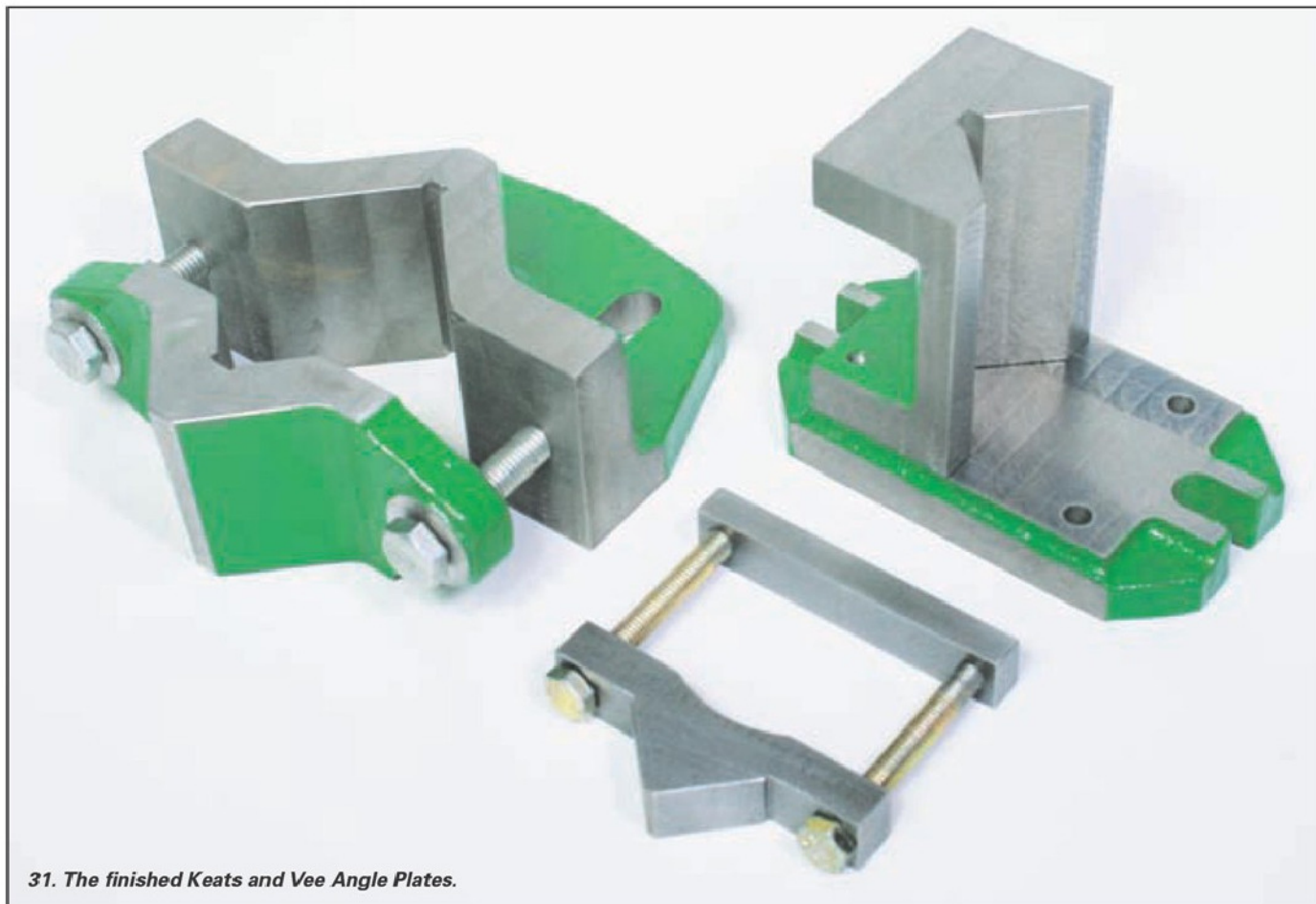
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HOW TO MACHINE CASTINGS

3

Harold Hall compares the Keats and the Vee angle plate



31. The finished Keats and Vee Angle Plates.



32. The Keats and the Vee Angle Plate holding the maximum sizes possible.

OVERVIEW

In the last two issues the methods that I adopted for machining the Keats Angle Plate and the Vee Angle Plate were described, the castings for both being available from The College Engineering Supply. The articles were provided mainly with the novice metalworker in mind and in particular with the approach to machining castings generally.

up to 75mm. Whilst in theory it will hold very small diameters, say 8mm, it would though be rather unwieldy for such small workpieces.

The maximum diameter that the Vee angle plate holds is 50mm and therefore much more appropriate at smaller diameters. To illustrate the differences **photo 32** shows them holding material at their maximum diameters.

While I am comparing the two items it is also appropriate to compare them to the 3 or 4-jaw chuck that they may replace in some applications. Taking my 100mm 3-jaw chuck, the maximum diameter that can be safely held using the standard jaws is 30mm diameter and at a jaw depth of

Having completed the two items as seen in **photo 31**, I will briefly compare them and give some idea as to their uses as far as I can. I say "as far as I can" as what is frequently explained as the purpose of the Keats is a task in which I have very little experience, more about that later.

The two compared

Whilst both can satisfy what most will consider to be their main use, that is to be fixed to the faceplate where it will be used to hold a round component, either on or off centre, the main difference is in the size of the workpiece that can be held. In this respect the Keats will hold diameters



33. The Vee Angle Plate can be used horizontally and its fixing lugs are a distinct plus.



34. Machining a large bar on the lathe whilst held in the Keats Angle Plate.

15mm, this comparing with a depth of 45mm for the larger Keats. This greater depth would be of considerable benefit if a long workpiece was involved.

At even larger diameters, where the reverse jaws are required, the gripping length of the chuck jaws is just 7mm, the Keats being a vast improvement in this situation. On the down side, ensuring the part is running true is quite a tricky operation for the Keats. Comparisons would be similar when holding larger square material compared to using the 4-jaw chuck. To a lesser extent, similar benefits are provided by the Vee angle plate.

The Vee angle plate can though be set up with the Vee horizontal to the base when it could then be used as a conventional Vee block. However, a definite plus is the presence of fixing lugs that make it easier to secure on the machine table or even the faceplate (**photo 33**).

Uses

The most prominent use mentioned for the Keats, if not the only one, is in many cases for machining the crankpin on a crankshaft and it is highly likely that this is the reason for its design being produced in the first place. This use is though a subject that I only have limited experience of, just two very small crankshafts, where I have used other methods. Whilst items can be set off centre using the 4-jaw chuck the distance is very limited and far short of what is needed when machining a crankshaft, because of this, the Keats is the only viable option for larger crankshafts. In the case of smaller crankshafts, such as a found on the small Stuart steam engines, a fixture is almost certainly the best approach.

Having made these comments it would seem that the Keats angle plate has no purpose in the home workshop unless larger crankshafts are to be made though some may use the Vee angle plate for smaller shafts. This though overlooks the fact that they can both find applications beyond this one task. Typically, as the Keats is likely to be able to hold diameters larger than the available chucks then it can



35. Making a large nut using the Keats to hold the workpiece whilst mounted on a rotary table.

take their place when larger diameter work exists, **photo 34** being an example.

These devices are not though limited to just being used on the faceplate and using them on the milling machine table proves useful in some cases, particularly as they are able to hold round workpieces much more securely than say a vice or an angle plate. A good example being that shown in **photo 35** where a hexagon for a large nut is being made and being indexed for the task whilst mounted onto a rotary table. There is however, another major advantage compared to the workpiece being brought to the rotary table already fitted in the 3-jaw chuck and screwed to an adapter mounted onto the table (**photo 36**). This is that if attempting to use the chuck in this way, the rotation of the cutter will be attempting to unscrew it from the



36. If a chuck was used in place of the Keats, the action of the cutter would be to unscrew the chuck from its mounting. This is definitely a method that should not be used.

adapter. The method should not therefore be used under any circumstances as it is potentially very dangerous.

The workshop owner should not therefore overlook these other uses and will no doubt find that, despite their limited use, they will on occasions make a very difficult task relatively easy, or an impossible task, possible. ■

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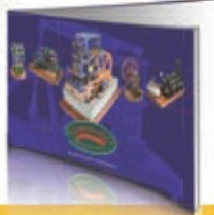
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EDGE AND CENTRE FINDING 2

Michel Christiaens looks at work setting

Electric and electronic edge finders

These come in mainly two variants but their functioning is largely the same. In principle an element (a cylinder **fig 5** or a ball **fig 6**) of known dimension is brought into contact with the edge or plane to locate (**photo 16**). When the probe touches the workpiece a LED lights or a sound is heard. For these tools to work, it is imperative that the material is electrically conductive. It will not work on plastics and the like. There may be however, a work around. Put a steel feeler gauge between the work piece and the edge finder. Of course the feeler gauge should also contact the vice or the table (**photo 17**). When using this method, care should be taken that not only half the diameter of the probe but also the thickness of the gauge has been taken into account.

These edge finders can be used stationary or while they are spinning. In the latter case, upon contact, the LED will not light steadily but it will flicker due to varying contact conditions.

The kind of tool with a ball as a measuring element is somewhat more foolproof (and more expensive) than the ones with just a cylinder. The ball is held by a tension spring and gives a little way when pushed too far. This stops the cylinder from deforming and becoming useless.

By all means, before using this kind of edge finder, first test it. The internal button cells do not have a permanent life and, particularly when a finder with a cylinder is used, a flat battery could lead to the conclusion that the edge is still not reached whereas the probe is already deformed beyond repair.

The laser edge and centre finder

If you believe the publicity this device is the ultimate to "accurately and quickly establish location points, edges, centres

OVERVIEW

Following on from the last issue, I will be looking at electric, electronic and laser methods of edge finding.

of material, centres of holes, scribed lines, alignment of vices on mill tables, the centring of rotary tables and spin indexers". Well... I did believe the buzz and bought myself one. It was expensive, the more so because I also bought the polariser to narrow the spot still further (**photos 18 and 19**). It certainly is a very nice idea. Laser light is coherent, meaning (among other things) that the light beam stays almost perfectly parallel and doesn't diverge much over long distances and the light can be seen. Care should be taken though, not to shine the laser light directly into the eye. This is very dangerous and could cause blindness. So, in this application, a thin laser beam, generated centrally in a device that's chucked in the spindle of the mill or drill, shines on the workpiece. That way a scribed line or an intersection of two lines can be located by projecting the spot on them. Or, in the case of an edge, the beam shines on the edge and the moment the centre line of the spindle coincides with the edge, the beam is split "in half" and half the spot can be seen on the surface of the work piece. Down the vertical plane shows a line. Well, it may work for everyone, but not for me. This device disappointed me very much. For what I ask of it, it is by far not accurate enough although fortunately I found another use for it. My mill-drill has a round column and whenever I change height I loose my reference position. Now I have made a holder so the laser beam is projected onto the wall six feet behind



16. A electronic edge finder. When the cylinder is in contact with the workpiece, the LED inside will light.

the mill where a vertical line serves as reference (**photo 20**). Due to the long distance the, movement of the spot is much amplified resulting in more accuracy.

A dial test indicator

As far as I know a dial test indicator can not, on its own, be used to locate the edge of a work piece. There is though a means to put this little devil at work to help us with this task with the assistance of a little device called "an edge locating



17. The electronic edge finder with a non-conductive work piece. A feeler gauge is called to help.

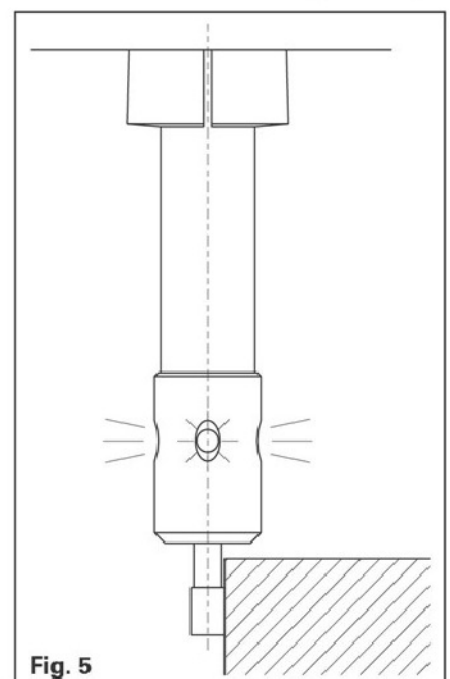


Fig. 5



18. The laser edge finder. Here without a polariser.



19. The same laser edge finder but with a polariser to have a sharper, narrower beam.



20. Used for totally other purposes than edge or centre finding...



21. The "chair".

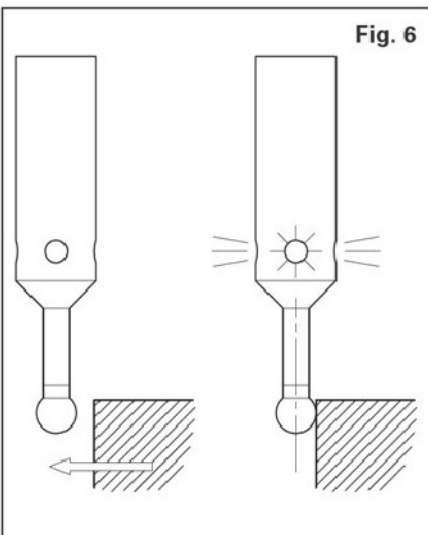


Fig. 6

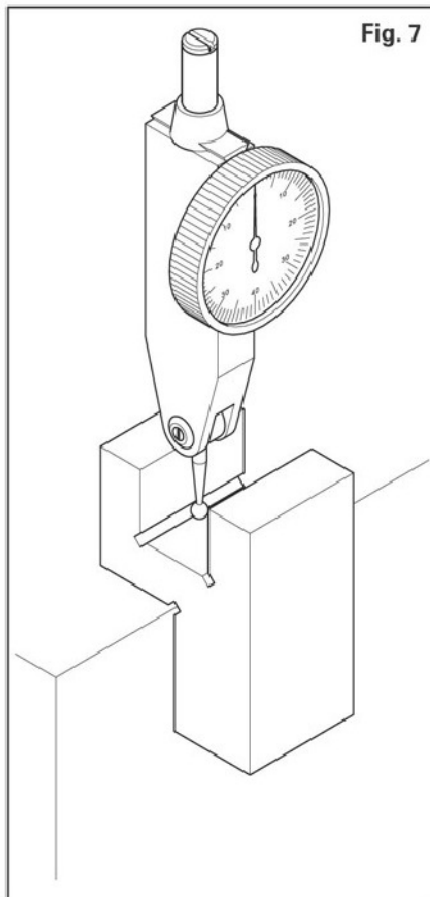


Fig. 7

chair" (photo 21). As a matter of fact, there are two kinds of these. The most simple is kind of an angle plate with a slot on the upside. The centre line of the slot is machined very carefully to be in the same plane as the vertical member. The device is placed on the edge to locate with the gap pointing upwards (fig 7). Push it firmly against the vertical surface. Touch one side of the slot till the DTI reads "zero" or something you will remember. Zero the axis or the DRO as well. Touch the other side till the DTI reads "zero" again or the same as you remembered earlier. Then read how much the displacement of the table was. Divide by two and you know how far the spindle axis is still away from the edge.

There is a variant of this little tool that allows locating the tangent of two edges by measuring four times (fig 8). The hole is either square (rare) or round (more common). Measuring in a round hole is somewhat more difficult and it is important not to change the axis between two measurements because without special precautions you can't be sure that the probe of the DTI is exactly on the centreline of the hole in the edge locating chair.

When this little instrument is in use one is sometimes short of a hand so a clever person had an idea to make it magnetic. Of course this only helps if the work piece is magnetic too.

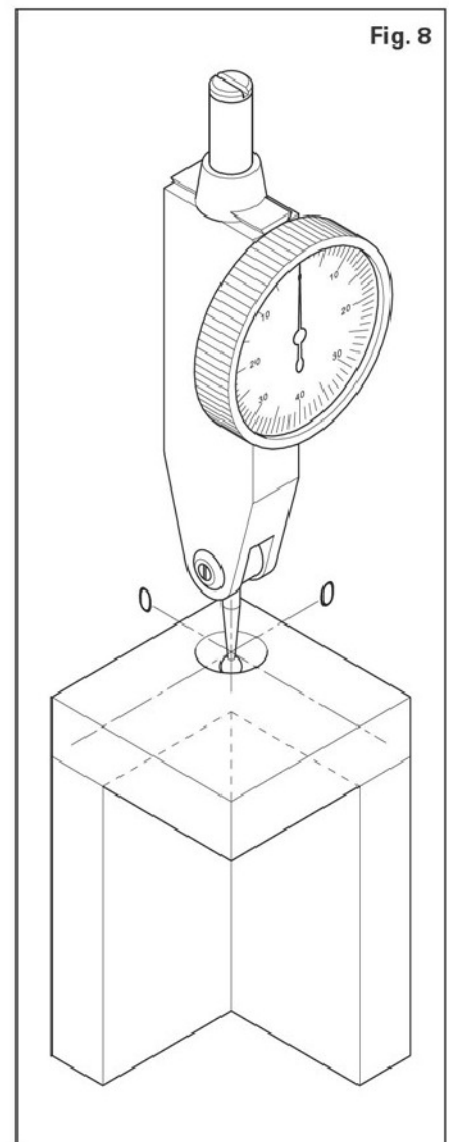


Fig. 8



22. The co-axial indicator with some probes.



23. The co-axial indicator ready to use.



24: Centring an external diameter.

More expensive measuring instruments

The co-axial indicator

This instrument (see photo 22 and fig 9) comes as a set with several probes to locate centres in different ways. Let it be clear: this instrument is not meant to find edges though it is possible to align a vice with it! There are three different feelers or probes and each (except the centre point) come in three different lengths to extend the range of the instrument.

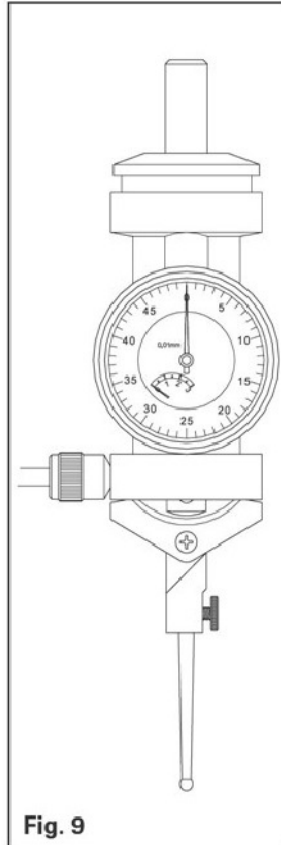


Fig. 9

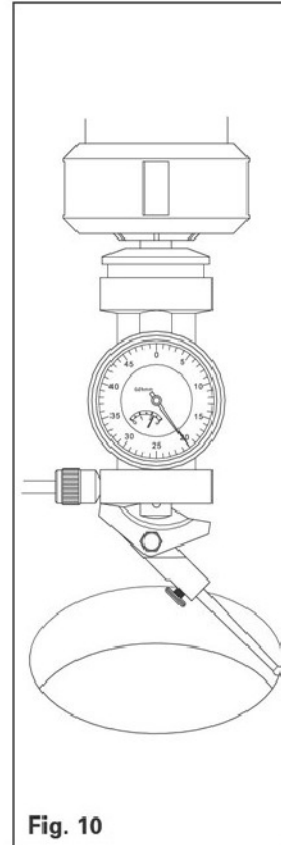


Fig. 10

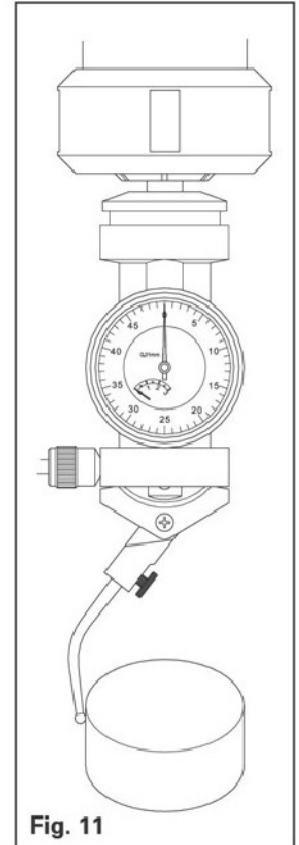


Fig. 11

According to what you want to do (finding the centre of an internal diameter (fig 10) or an external diameter (fig 11) a straight or a curved probe is chosen and mounted in the base of the dial indicator. To that end there is a thumb screw with which the probes can be fixed securely and easily (photo 23).

This instrument has a distinct advantage over a "normal" dial indicator or a dial test indicator when used to find the centre of a part: the indicator dial remains stationary while the machine spindle rotates leaving the operator with both hands free to make adjustments. Readings can be taken without the user having to contort his neck (or use a mirror) to read the dial round the back of the machine. Rotating the spindle is possible either by hand or with the motor. Of course it's advisable to use a very low speed when the motor is used. There is a retaining arm that is screwed in the instrument so it can be held steady while the spindle is turning. That way, the dial always faces the user.

There is also a centre point that is used much like a sticky pin, a wiggler or the pointed edge finder (fig 12). Set it first to run true and then the scribed lines or the centre punch must be placed right under the nearby point.

Because of the use of probes of different lengths and the fact that the dial indicator has but one scale, the readings are just there as a reference and must be interpreted as a relative measurement, not as absolute ones.

Setting and operating procedures is as follows (photo 24).

- 1) Choose the appropriate feeler and mount it in the indicator bracket. Secure it with the thumbscrew.
- 2) Chuck the indicator, preferably with a collet.

- 3) Position the rocker bracket with the rocker friction joint so that the feeler is in contact with the part of the workpiece we want to find the centre of.
- 4) Screw in the restraining arm to the side of the indicator and rest it against a fixed object.
- 5) Rotate the machine spindle. If the motor is used, use no more than 500 RPM.
- 6) Move the table along **one** axis at a time so the indicator needle rocks the least amount possible.
- 7) Move the table along the other axis until the needle moves as little as possible.
- 8) Repeat 6 and 7 to make the indicator hand move just a little or nothing.
- 9) You're on centre! **To be continued...**

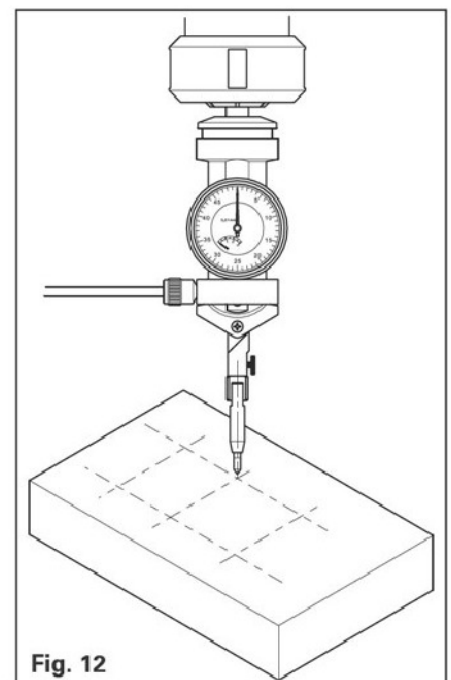
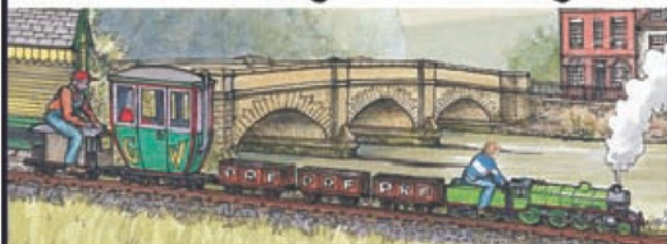


Fig. 12

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UPDATING THE MYFORD ML7 ONE-SHOT LUBRICATION SYSTEM

Tony Jeffree offers a lower component count making for a cheaper system



Photo 1.



Photo 2.



Photo 3.

Arc part number	Old Quantity	New Quantity	Description
084-025-00001	1	1	Pull handle oiler
084-025-00250	4	4	90 degree elbow hose adapter
084-025-00500	5	5	Banjo assembly
084-025-00606	1	1	Junction bar 6-way
084-025-00608	1	1	Junction bar 8-way
084-025-00602	6	2	Junction bar 2-way
084-025-00603	1	1	Junction bar 3-way
084-025-00100	5	3	AJB0 meter unit
084-025-00111	NONE	2	ASA(S)0 meter Unit - M8X1.0
084-025-00101	4	4	AJB1 meter unit
084-025-00120	NONE	2	ASA(R)2 meter unit - 1/8" BSPT
084-025-00102	2	NONE	AJB2 meter unit
084-025-00700	6	6	metres 4mm Nylon tube
084-025-00750	6	6	metres Spring Tube Guard for 4mm Nylon tube
084-025-00760	5	5	packs Ferrules for Spring Tube ends - pack of 6
084-025-00300	5	4	packs 4mm compression bushings - pack of 6
084-025-00350	6	4	packs 4mm compression sleeve (olives) - pack of 6
084-025-00800	1	1	packs 6mm tubing clip (1 tube) - pack of 4
084-025-00810	1	1	packs 6mm tubing clip (2 tubes) - pack of 4
084-025-00400	1	1	Blanking plug

OVERVIEW

In MEW issue 161, I described how to fit a one-shot lubrication system to the Myford ML7, using the components available from Arc Euro Trade. At the time I fitted the system, the metering units that were available from Arc were ones that were designed to be fitted into a manifold, and as a consequence, in some places I had to use 2-port manifolds as adapters to couple the nylon tube to the metering units. This led to a slightly ugly arrangement in some of the lubrication points, particularly the two headstock bearing points (photo 1) and the two leadscrew bearings (photo 2).

Since I wrote the article, Ketan at Arc Eurotrade has been able to source two new types of metering unit that are designed to be fitted directly into an oiling point. The first type is threaded 1/4in. BSP on its output side, and screws directly into the headstock bearing caps, and the second type is threaded M8 x 1.0, and screws directly into the 90 degree elbow adapters or the Banjo assemblies, or if appropriate can be screwed directly into an oiling point.

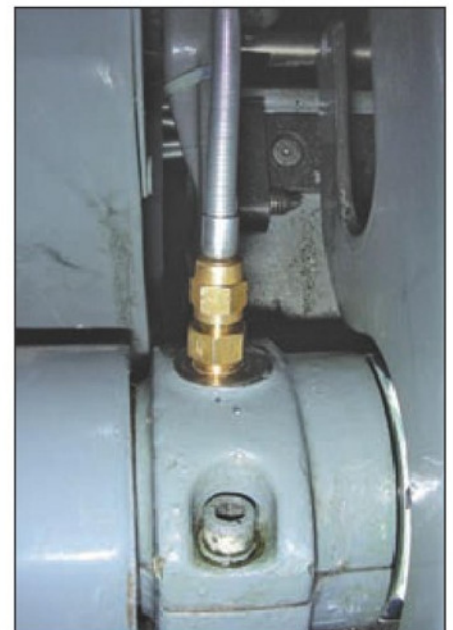


Photo 4.



Photo 5.

These metering units can be seen in **photo 3**; the pair on the left are the M8 threaded units, the pair on the right are threaded $\frac{1}{8}$ in. BSPT. In both cases they are fitted with screw caps and compression sleeves (olives) at the inlet side so they can take a 4mm nylon tube without further adaptation. Consequently, these units can simplify the plumbing arrangement used for the headstock and lead screw bearings, as can be seen in **photo 4** and **photo 5** respectively. The M8 threaded unit screws directly into the Banjo assembly that is

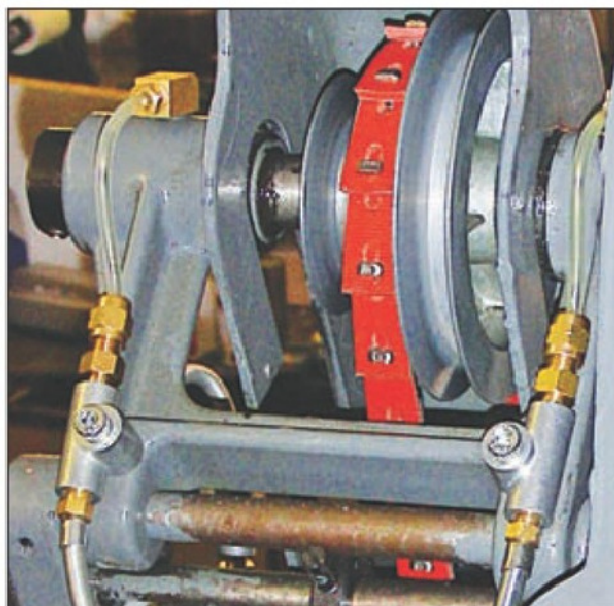


Photo 6.

fitted to each of the lead screw bearings; I used Loctite threadlocker on the M8 threads to seal the joint before screwing the metering unit into the banjo assembly. The $\frac{1}{8}$ in. BSPT metering units are a taper thread, so the harder you screw them into the bearing shells, the tighter the thread "fit" will be; there isn't any real need to seal the threads any better than they will seal as a result of the taper fit.

The M8 threaded units could also be used for the countershaft bearings, where they would screw directly into the 90

degree elbow hose adapters used at these points; however, as the metering units would then stick out to the back of the countershaft bearings I felt that there was no need to change the existing arrangement shown in **photo 6**.

These changes obviously have an impact on the bill of materials for the job. The table opposite shows the Arc Euro Trade part numbers and the old and new quantities required. Rows in the table that have changed as a result of these modifications are shaded. The result is a useful reduction in the overall cost of installing the oiling system. ■

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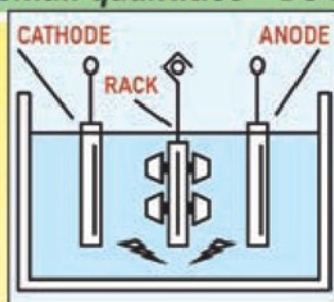
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METHOD AND MADNESS

Dave Fenner looks at batch production



1. Length of flat bar with eight holes for four parts.

One of my incurable traits is a tendency to be something of a grasshopper mind. Partway through a four-stroke project, I fell over some information on 16mm Narrow Gauge Railways, and decided to experiment a little. For those not familiar with the format, the scale is 16mm to the foot, and models are usually based on two foot gauge prototypes, thus run on 32mm or O gauge track.

Unlike standard O gauge, where the scale is 7mm to the foot or 1:43, the scale here works out as 1:19 which is a step or two further removed from watchmaking. Numerically it lies between the 2.5in and 3.5in standard gauge scales.

A conversation with our esteemed editor, who is a long term enthusiast of 16mm, unearthed drawings for a suitable Festiniog prototype, Harlech Castle, and these were used as a basis for a chassis. Harlech Castle is an 0-6-0 diesel with outside frames and outside cranks. For these latter components, I would need a total of eight identical parts (six for the three axles and two for the jackshaft).

Figure 1 shows the component in question, along with the rectangular outline of the method 2 individual blank.

Method 1

The initial thinking was to turn blanks to diameter and thickness, drill the axle and crankpin locations, then mill to width and shape. This avenue was indeed initially pursued as far as cutting blanks from 22mm bar. With any small scale locomotive, to ensure free running linkages, quite a high order of accuracy must be maintained as regards the cranks

(repeatability of throw), and the coupling rods (bearing centre spacing to match axle centre spacing).

On reflection, my feeling was that working with individual blanks would invite the possibility of inaccuracies creeping in, due to the repeated mounting and remounting of work for drilling the

OVERVIEW

There is often more than one way to make a component. The more experience you have with machining, the more ways you are likely to consider. Dave considers the options in make a set of eight identical locomotive cranks.

pairs of holes. Certainly this could be achieved fairly precisely by the use of stops, or by employing one setup then moving the throw radius as determined by the DRO or axis handle scale.

Method 2

At some stage I recalled a batch machining job, many years ago, which I passed to a local firm to be machined on their CNC mill. Each part had two or three holes, at least one of which was threaded, and they chose to produce it in "bar batches" on the mill, a little like bars of Toblerone chocolate. Before starting they did a test on their saw to measure the kerf width. Let's say the result was 2mm, and let's assume the width of the part was 20mm. They then programmed the mill to drill the required features at 22mm spacing, allowing the individual items to be sawn off after drilling. The same philosophy would work here. Instead of starting with round blanks, the raw material was 0.875 x 0.25in. (22.2 x 6.35mm) bright flat steel. (There is a

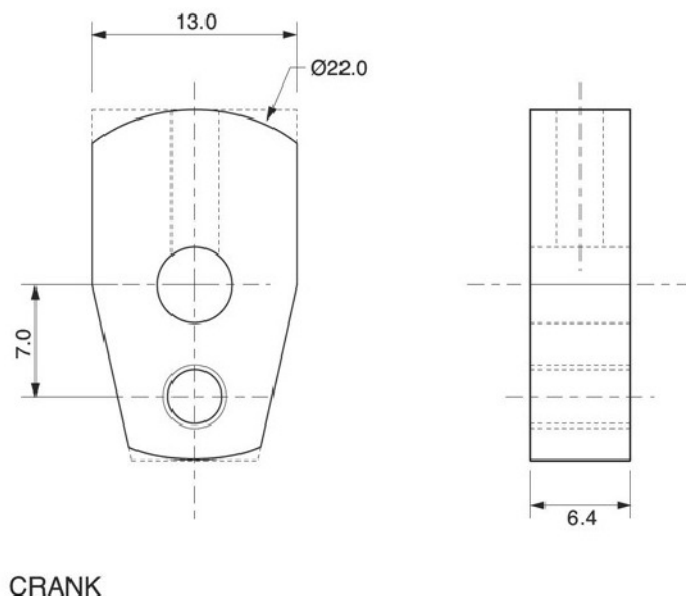


Fig. 1

slight disadvantage here as the flat bar is unlikely to be readily available as free cutting steel.)

My selected method for sawing off would be by circular slitting saw held in the mill, the blade thickness being 0.0625in. (1.6mm), which would be added to the component width to obtain the correct hole spacing. **Figure 2** shows a multiple blank for four components.

It was then a simple matter of pitching a line of holes along the centreline at this spacing, (X axis movement) then moving in the Y direction by an amount equal to the crank throw, and repeating the process. This would ensure that all crank throws in a block of four, would be identical. **Photograph 1** shows eight holes spotted with a centre drill to make four components.

To slice off at the correct position, it was necessary to set the height of the work with reference to that of the saw blade. A correctly sized rod (diameter D1) was passed through a hole in the multiple blank and the drop to the blade checked against a number drill sized to match the dimension (diameter D2). For the crank width of 13mm, D2 plus one half of D1 equals 6.5mm. **Photograph 2** has been staged to illustrate the theory, while **photo 3** shows the set up actually used, where the height of the work is set by rods contacting the vice jaws, and can be reset vertically upwards after each item is severed.

After the other operations such as drilling and tapping for the locating screw, each crank was fitted to an arbor to turn the corners away (**photo 4**) to giving a partly circular outline.

Conclusion

The adopted method certainly delivered a set of cranks which would work well from a mechanical point of view. Subsequent cutting of the taper faces revealed that more attention could have been paid to the cut off position. Although the error was quite slight, (less than five thou) the effect on the position where the taper intersects with the parallel side is magnified by the shallow angle. This visual effect could probably have been minimised by very careful measurement of the first off leading to a slight adjustment for the remainder, perhaps making ten in total allowing the first one or two to be sacrificed. ■

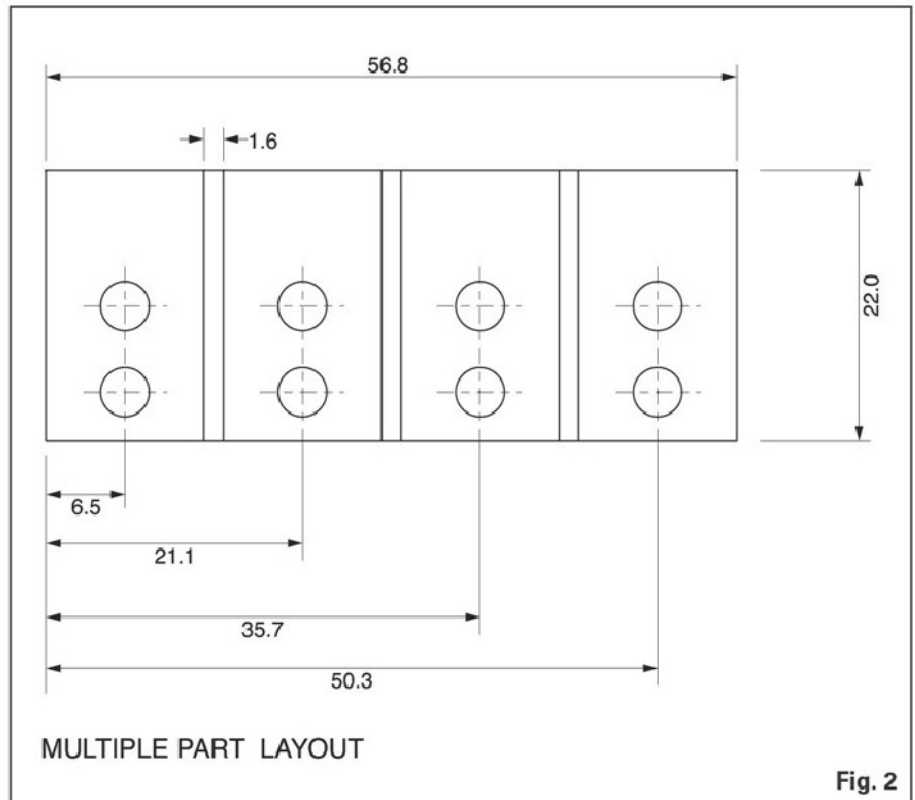


Fig. 2



2. Method of setting cutter height.



3. Method for repeatable setting of work height.



4. Turning away the corners.

LUBRICANTS FOR THE HOME WORKSHOP

Mike Houghton looks at the basics of lubrication and lubricants

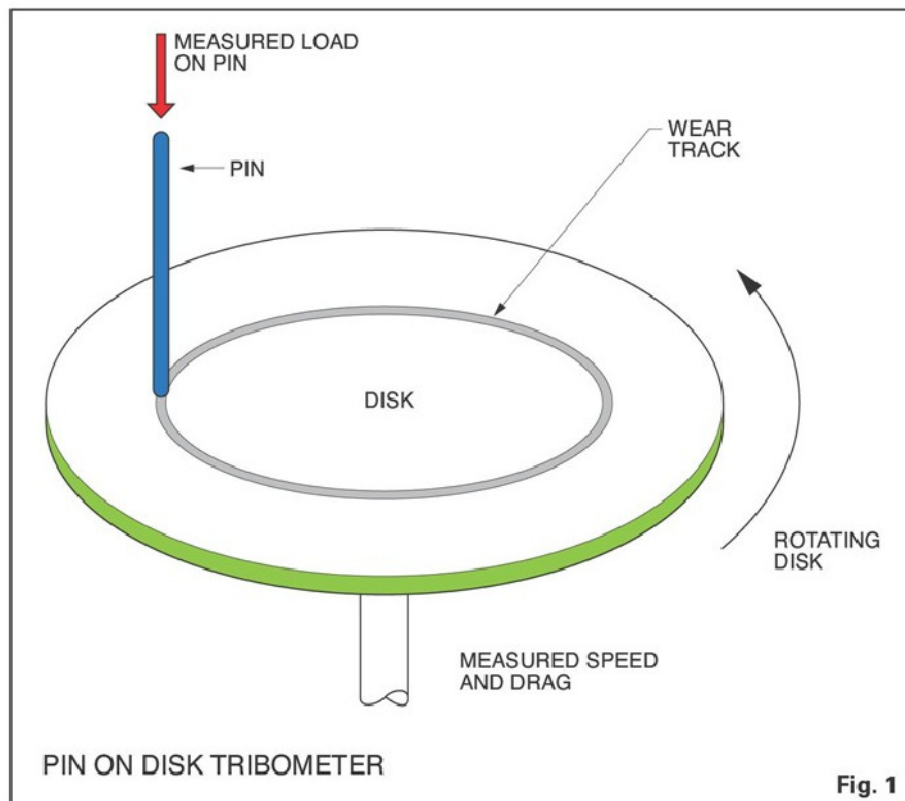


Fig. 1

Friction

Imagine pushing that newly delivered cardboard box of heavy castings over a carpet. It takes quite a push to get the box moving and a smaller push to keep it moving. You have overcome static friction between the carpet and the box and found that sliding friction is less.

If you were to place the same box on rollers, on the same piece of carpet, you would find it takes less push to get the box moving and less push to keep it moving.

If you put the same box on a polished tiled floor, the push to get the box moving is less and the push to keep it moving is less than on the carpet. Placing the box on rollers on a polished tile floor would take even less push to get it moving and keep it moving.

Conclusion: friction is very dependent on the materials in contact, their load and the condition of the sliding or rolling surfaces.

Sliding and rolling friction creates heat. There are a couple of brilliant Thompson videos on YouTube showing friction welding ([ref 1](#)). Here you will see two large pieces of metal oil drill pipe, one static and one rotating being brought together, end on, with a huge force. Initially sparks can be seen as the metals touch. The contact zone rapidly heats and the metal in both pieces flows to form a "weld". Friction produces heat!

However, friction isn't all bad, it holds Morse taper tooling static in your tailstock; your lathe carriage static on the bed when you apply the clamp and the disk brakes

on your car slow you down with the production of heat.

Science recognises static, sliding and rolling friction and can measure a coefficient of friction for individual pairs of materials. In this discussion we are only interested in solids, but the same principals can be

OVERVIEW

The use of a lubricant to reduce friction and wear between metal parts that are in moving contact is second nature to the mechanically minded. We don't think about what's happening, or how it works, we just instinctively add some oily lubricant. Things run quieter, cooler and with less wear when a lubricant is present.

If we are machining, the correct choice of cutting lubricant can improve surface finish in turning, milling, drilling or reaming and reduce galling or pickup in threading operations.

applied to liquids and gasses. Generally the coefficient of static friction is greater than that for sliding friction and both are less than the coefficient for rolling friction. At this point I was going to compare reported coefficients for different engineering materials, steels, bronzes, Teflon etc but found that the numbers are so dependent on the test method and surface condition that I decided just to give a reference to a source. Please see the references in [ref 2](#), should you wish to read more.

A low coefficient of friction number means low friction and less heat production. The surface condition of the sliding or rolling parts is important, especially the harder material if there is one, e.g. a bronze bearing and a hardened steel shaft is a frequent soft/hard bearing combination.

There are good reasons why clock and watchmakers prepare pivots by burnishing with a very hard steel or carbide

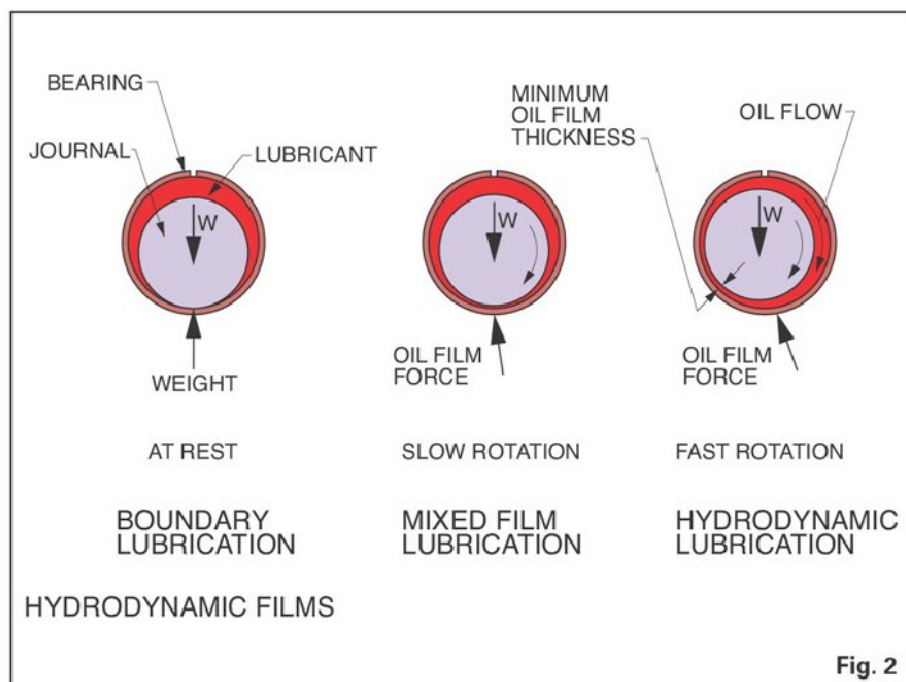


Fig. 2

burnishing tool and then polishing with a very fine abrasive suspended in oil. The results of these operations are low surface roughness, work hardening of the pivot and a long working life, even with a marginal lubricant supply.

In ball bearings and roller bearings the coefficient of friction is lower than for plain bearings. The cages and rollers of ball bearings are usually made from hardened and ground high chromium steel finished to very exacting low surface roughness specifications.

The Pin on Disk Tribometer

Imagine a motorised rotating platter, rather like a gramophone turntable, and a pin that can be pressed into the platter (fig 1). The instrumentation allows the disk speed to be measured and the drag due to the friction of the pin. The pin force is controlled and measured. The whole assembly can be flooded with lubricant and temperature controlled. Microscopic examination of the pin and disk allows wear damage to be measured. Needless to say, without lubricant, most combinations of pin and disk materials show wear at quite low loads and quite low speeds. Adding a lubricant allows much higher loads and surface speeds for most pairs of materials used to make the pin and disk.

The thin layer of lubricant on the disk surface effectively prevents the pin touching the disk. Tests show that higher pin loads are possible before wear occurs, if a lubricant is present.

Pin and disk tests carried out with thicker lubricants (higher viscosity) show that higher loads can be supported when the viscosity of the lubricant is higher.

Under normal atmospheric conditions the disk test material will have a surface coating of oxide, plus, possibly, carbonate, or hydroxide and sulphate that can be shown to adsorb lubricants. (A measurable heat of adsorption occurs when the lubricant and the metal surface come into contact). It hardly matters how the test metals are prepared; they will have a contaminated surface because of the atmosphere, with the possible exception of "noble metals" gold etc. The surface layers of metal may also hold a "memory" of how it was machined. Aluminium and chromium have particularly thick and tough oxide layers, hence their apparent resistance to corrosion. The chemi-adsorbed lubricant is only likely to be a few molecules thick and completely dwarfed by surface imperfections left by machining, however, it's important for boundary lubrication conditions. Some polar materials absorb more strongly than simple hydrocarbons and may function as "friction modifiers".

Tribology

Tribology is name created in the 1960s for the study of friction wear and lubrication; it is the science of interacting surfaces moving relative to each other.

Figure 2 is a very simple plain bearing with oil lubrication. The clearance between the journal (Shaft) and the bearing are deliberately exaggerated.

At rest, the journal rests on the supporting bearing. If the supporting bearing or the shaft is rough it is likely that the two parts will only be in contact at the high points (Asperities). When rotation

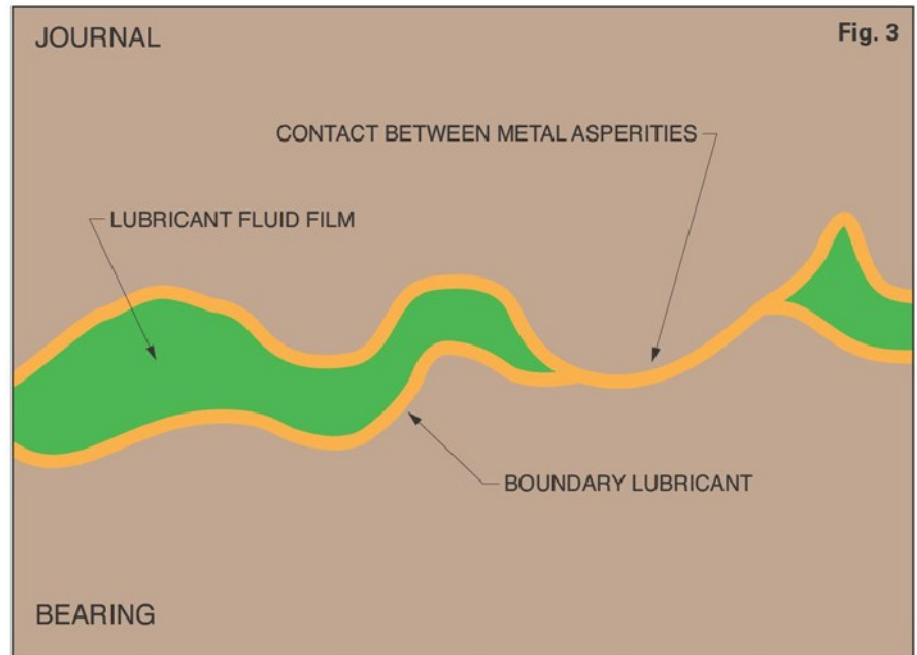


Fig. 3

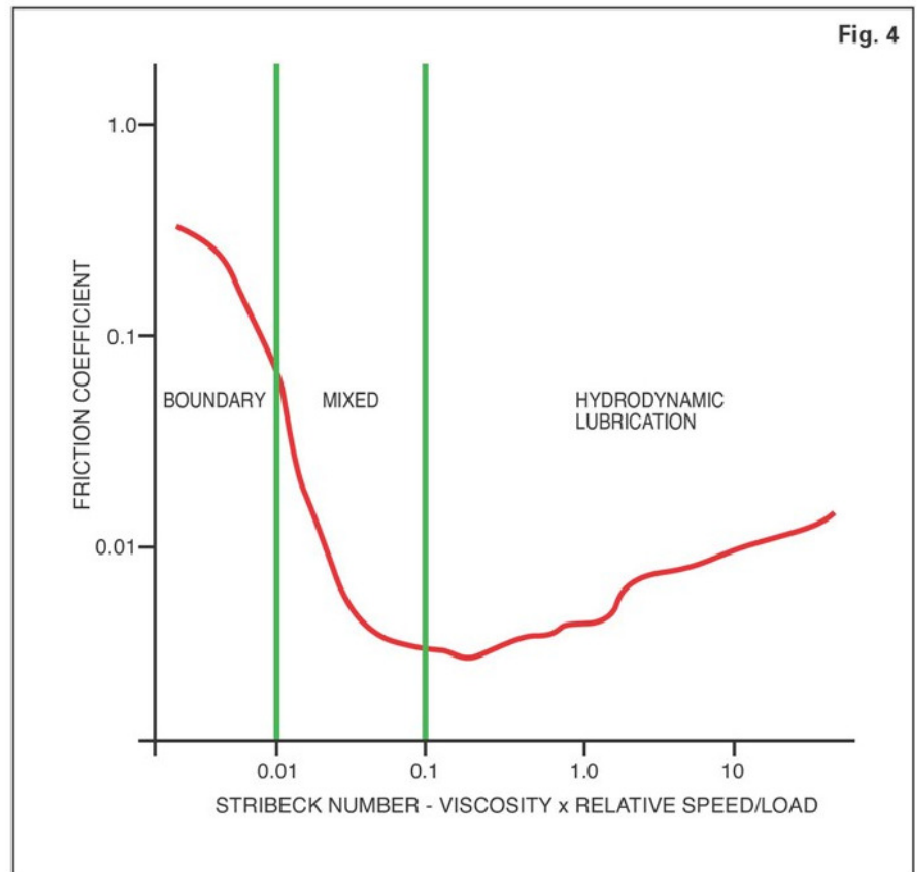


Fig. 4

commences, the shaft starts to climb up the bearing and carries a thin film of lubricant into the contact region. As the shaft rotates faster the oil in the wedge region becomes pressurised such that it supports the journal weight W . Hydrodynamic lubrication can be compared to aquaplaning of a car tyre on a wet road. With a minimum film thickness of 0.001in. a lubricant pressure of 40 to 400p.s.i. is said to be possible.

Figure 3 shows a diagram of two static metal surfaces, a journal and bearing for example, which have a boundary lubricant layer adsorbed to the metal surfaces. The two boundary layers are in contact at the asperities or rough protrusions on the

surface. Only a small area of contact is likely so the softer of the two metals could be deformed because of the high load per unit of contact. Once the two metal surfaces start to move slowly over each other, wear will take place. There are many sorts of wear; the journal and bearing materials plus the loading mostly determine which wear processes predominate.

See my later comments on "extreme pressure additives" (EP) and "lubricity additives".

Friction experiments on bearings lead Stribeck (ref 3) to produce graphs of friction coefficient against viscosity, load and velocity. One version of the Stribeck Curve

is given here showing the 3 areas of lubrication types. The Curve is a plot of friction coefficient as it relates to viscosity, speed and load. Note that both the horizontal and vertical axes are log so each tick is 10X larger than the previous (fig 4). At low speeds and high loads the lubrication is said to be in the boundary condition where the coefficient of friction is high and wear quite rapidly occurs. Most machines see boundary lubrication conditions during start up. In the hydrodynamic lubrication area a thick lubricant film keeps the metals apart and there is little wear and low friction.

Stick slip

For surfaces at rest the Stribeck curve shows a higher friction coefficient than when they are moving. Our experiment with the box of heavy castings on a carpet illustrates this. If we apply an increasing force the box sticks on the carpet then suddenly moves or slips forward. In some machines e.g. the slide-ways on lathes and especially on CNC machining centres additives are added to the lubricant to reduce stick slip.

Jo Blocks (slip gauges)

Named after their Swedish inventor, Johansson, these blocks can be wrung together to form assemblies of exact thickness. Blocks with the CEJ logo are still being made and often turn up in workshop clearances. There are lots of other makers of course. Originally of chromium steel, but now more likely to be made of ceramic or carbide, these blocks are ground and lapped to an exact size and have very low surface roughness. Slid or wrung together they stick and behave as one. It can take up to 100kg force to separate them. It seems likely that the surfaces are so flat, only very small and many asperities, combined with an oil film to exclude air plus metal to metal attraction are responsible for the sticking. The oil film thickness is undetectable even with the best micrometer. The best grade blocks are sized to ± 0.05 micron or ± 0.000002 ", but even that's considerably larger than an oil molecule in a boundary lubricant layer.

Oils, fats and waxes as lubricants

Man has probably been adding lubricants to metals and non metals ever since the first wheel was invented, possibly even earlier. Early lubricants chosen were often readily available waxes, oils and fats that felt oily and slippery on the skin. Examples might have been animal fats, fish oils, seed oils and waxes. How can such a diverse collection of materials act as lubricants?

The common chemical theme running through this collection of naturally occurring materials is the presence of fatty acids combined with alcohols to form esters.

Fatty Acid + Alcohol $\rightarrow$ Ester + Water

Most oils and fats are tri fatty acid esters of Glycerol; most waxes are fatty acid esters of long chain alcohols.

Naturally occurring fatty acids have long carbon chains; on average around 18 carbon atoms in unbranched chains. (A generalisation, yes, I know there are exceptions!) These fats and fatty acids are virtually insoluble in water, but dissolve

easily in hydrocarbons and other oils, natural or mineral (from petroleum).

Adding an alkali and water to a fat or wax will result in the production of soap.

Fat + Alkali + Water $\rightarrow$ Soap

As we shall see later, soaps are critical ingredients in lubricating greases.

Natural oils and fats can have some disadvantages as lubricants. I can vividly remember, as a young thing, servicing a Singer sewing machine for my Grandma. After cleaning and adjusting I oiled it with edible olive oil. It worked fine; I was congratulated, but after being put aside for a week or two the machine was found to be seized solid!! The olive oil had oxidised and thickened in the bearings.

Many natural fatty acids in oils and fats contain unsaturation in their carbon chains and these C=C bonds are quite easily oxidised. This unsaturation can also be used to our advantage. E.g. Lard oil reacted with sulphur can give some very inexpensive "extreme pressure" (EP) metal working additives. ("Sulphurised lard oil").

Fats and oils are also subject to microbiological attack, they can easily go rancid with the production of fatty acids which are quite corrosive to many metals especially "yellow alloys". (Brasses, bronzes)

As we shall see later, natural fatty acid based additives and lubricants are experiencing something of a renaissance.

Petroleum based lubricants

Natural fatty materials were satisfactory as lubricants until machines got faster, carried heavier loads and became more complex in the early industrial revolution. Some natural products, like whale oil, started to run out and Petroleum quite rapidly became the major source of lubricants from about the 1880's. Since

that time the technical requirements for petroleum based lubricants have constantly evolved due to developments of the use in industry. Just think how automotive engines have changed over the past 100 years and are still changing.

Crude oil contains an amazing and complex mixture of hydrocarbons and no two crude sources contain the same mix of ingredients. Crudes are unsuitable as lubricants without further processing and have to be split into fractions by distillation. This is usually done in two stages, atmospheric pressure distillation followed by vacuum distillation of the residues. These residues are normally the source of lubricant stocks. Vacuum distillation is used to reduce thermal breakdown during the processing (fig 5) which is a schematic of the two distillation processes. The whole process is continuous and carried out on a massive scale; an atmospheric distillation column can be over 100 metres tall.

Looking at fig 5 to the left, crude oil is fed to a desalter unit that removes water and salts, which are very corrosive: it is then heated and fed to the centre of a multi-tray fractionation column where lighter components flash off and travel up the column. Less volatile heavy components flow downward and some will appear at the bottom of the column as a residue to be reheated and fed to a vacuum distillation column.

In fig 5, I have indicated the boiling points and carbon numbers of the various fractions. So C1 is methane, C4 butane etc. In reality, most oil refineries don't actually produce lubricating oils because their feedstocks are unsuitable and because lube oils are only a minor tonnage product stream compared to say gasoline or diesel. Somehow the refineries must match their output to the market demand and there is a lot of downstream processing to chemically

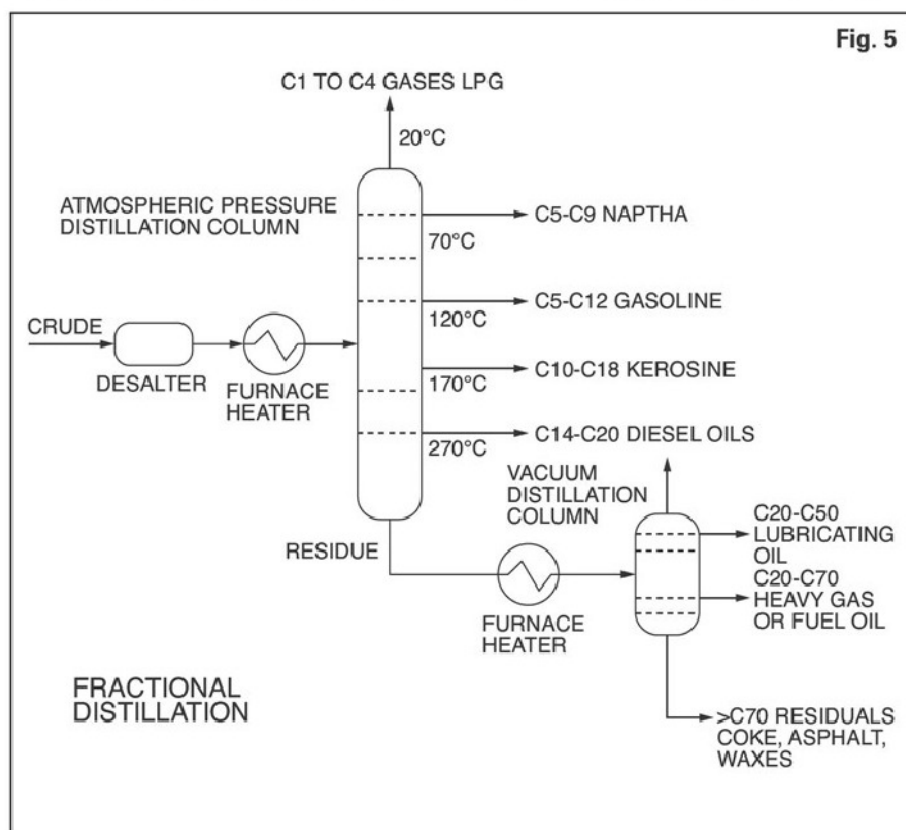
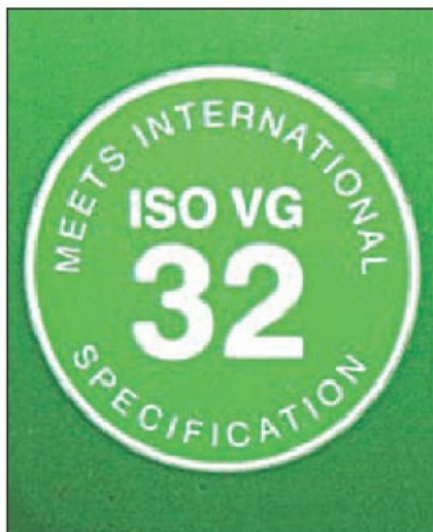


Fig. 5



1. Formulated mono grade hydraulic oil label.

convert low demand streams into useful products. The current high price of crude oil dictates increasingly frugal production schemes.

The lubricating oil distillation fraction shown above is still unsuitable for use. It will probably set solid close to room temperature due to waxes freezing out and might contain undesirable aromatics (molecules containing benzene rings).

One method of characterising the soup of hydrocarbons in crude and distillation fractions is to determine CP, carbon present as paraffins, CN, carbon present as naphthenes, and CA, carbon present as aromatics. Straight chain paraffins, part of the CP total, have the best lubricating properties, they have the best load carrying properties but easily freeze; naphthenes are better solvents and have good low temperature characteristics but poor viscosity temperature performance and Aromatics are usually undesirable for skin contact and often swell rubber seals etc. The aromatic Naphthalene is now classified in the EU as a suspect cancer agent.

The lube oil fractions produced by vacuum distillation are usually further refined by solvent extraction, de-waxing and frequently hydrogenated to remove aromatics, waxes and unsaturation. The end result will often be a "Solvent Neutral" "base stock" of a closely controlled viscosity. These base stocks are internationally traded and frequently form the raw materials that blenders buy in as a key ingredient for their formulations. Typical lube base stocks will be traded as 80SN light spindle oil, to about 500SN heavy cylinder oil. The numbers in these grades refer to their Saybolt viscosity.

The lowest viscosity grades are frequently sold as "white oils" for use in pharmaceutical and cosmetic products (ref 4). The highest viscosity grades, 650 to 1500SN are likely to go into steam cylinder oils. Yes, they are still available.

The use of hydrogenation to improve lube stocks also causes the removal of sulphur containing materials that are natural EP agents; frequently these have to be replaced with additives in the final blending operation.

The removal of sulphur from diesel and petrol to meet increasingly strict emission controls has also had the side effect of reducing the boundary lubrication of fuel

injectors, leading to wear. Fuel additives are used to counter this effect of low sulphur. Adding esters as bio diesel methyl ester to low sulphur diesel from petroleum probably helps boundary lubrication. UK diesel is currently 2.5% green methyl ester, I think.

Viscosity and viscosity index

The viscosity ("thickness") of lube oils falls with temperature increase. As we have already noted higher viscosity gives better load carrying ability in bearings. It is standard practice in the industry to measure the kinematic viscosity at 2 temperatures 40C and 100C (it used to be 100F and 210F) in centi-stokes and to look up a viscosity index, VI for the lube. The original VI scale ran from 0, a large viscosity drop with increased temperature, to 100, a much smaller viscosity drop with increased temperature. Early lubes had a very poor VI, often close to 0 on the VI scale and as a consequence it was common practice to change automotive crankcase oils between winter, thinner lower viscosity, and summer, thicker higher viscosity.

Modern Solvent Neutral base stocks can often have VI's close to 100 without help from any additives. VI's of over 150 are not so uncommon in formulated crankcase oils. Some synthetic base stocks will exceed 150VI.

The oil industry abounds with strange and historic units of viscosity. E.g. Saybolt Universal Seconds (SUS); Degrees Engler; Redwood; Ford Cup etc. Inter-converting between the various units, especially when blending oils, used to be a nightmare but helped by the REFUTAS blending chart. Probably there are computer programmes to do these blending conversions now? In the UK you will probably find that heating oil is described as so many seconds viscosity, a throwback to the old units.

Viscosity grades

For lubricants used in applications where there isn't a great variation in operating temperature single (mono) grade or straight grade oils are satisfactory. For years lubricants were sold against SAE viscosity specifications (Society of Automotive Engineers e.g. J300 spec) The SAE system assigns the familiar SAE 30, SAE 90 etc. grades based on their viscosity measured at 40C. Comparatively recently the old SAE grades have been converted to ISO VG grades. **Photograph 1** shows part of the grade label on formulated mono grade hydraulic oil. This oil has a viscosity of

32 centistokes at 40deg.C, a use range of -9C to 63C and a VI of 90. It contains a number of additives to provide wear resistance, corrosion, rust inhibition and anti foam.

See ref 5 for a comparison of ISO VG grades and SAE. **Table 1** is for crankcase grades only, again see ref 5 for more detail and more lubricant types.

Table 1	
ISO-VG Grade	SAE Crankcase Oil Grades
22	5W
32	10W
46	15W
68	20W
100	30
150	40
220	50
320	60

For lubricants that have to operate over wide temperature ranges. e.g. hydraulic and crankcase oils in cold climates, refrigerator oils etc multi-grade oils can be the answer. The SAE W grades in this shortened table indicate the ability to pass a low temperature viscosity specification. The laboratory rigs used to determine these viscosities, the "cold Cranking simulator" for example is designed to look at problems starting engines and pumps at low temperatures.

Crankcase oils frequently sport an amazing list of specifications and approvals. **Photograph 2** shows a part of a UK Castrol SLX Crankcase Oil label intended for a Volkswagen turbocharged automotive diesel. This oil is a SAE 5W-30 multi-grade with a VI of about 160. ACEA is the European Automotive Manufacturers Association and this A3/B3/B4 grading is a set of performance requirements, including engine tests, that the formulation has to pass. VW 507 is an engine manufacturer's specification that probably includes an engine test protocol. At the present time there has been a divergence between US API engine performance specifications and European practice. These differences are driven by the larger numbers of small turbocharged diesel engines, fuel economy, catalytic emission and particulate control requirements in Europe. (And dare I say politics?)



2. UK Castrol SLX Crankcase Oil label.

Lube oil additives

Each refining stage of a lube base stock results in process losses or recycling of unwanted by-product material. It's usually more cost effective to add "performance enhancing chemicals" i.e. additives, to a base oil blend. Here I am specifically not writing about aftermarket additives of the very dubious "go faster, use less fuel, prolong the life of your engine" variety. I am writing about oil additives added to base oils to meet industry standards by blenders.

The Oil Additives Industry is truly massive, International and additive manufacture is split between the major oil refiners and specialist additive companies, e.g. Lubrizol. Formulated oil products might contain from 1% additives in hydraulic oils to over 20% additives in crankcase multi-grade oils.

So what are all these additives doing in the formulated oils? There are more additive functions than your average Swiss Army knife so this list is selective because readers of this article are never likely to be blending additives into base stocks, but do need to know the terminology to help ask the right questions and choose the right product for a particular application.

All of these additives actions are backed by laboratory test methods and specifications. Many of the test methods are ASTM (American Standard Test Methods). In general, lab tests are much cheaper and quicker to conduct than running engine tests, which in turn are cheaper than vehicles or machines in service, so lab tests have been developed to measure most of the following additive functions.

A) Pour Point depressants.

Cooling base oils will result in the straighter chain paraffins crystallising out and the oil going solid. The temperature where the sample no longer flows is the pour point. Pour point depressants act by modifying the crystallising waxes, preventing them from growing into large crystals. A very small quantity of PPD additive can give a big reduction in Pour Point.

B) VI improvers

These are generally polymer additives that dissolve in the oil to a greater extent at higher temperatures so propping up the 100C viscosity. Polymers are subject to mechanical shearing. High VI base oils reduce the need for these additives. Many VI improvers also act as Pour Point depressants.

C) Antioxidants

Oils that get hot and are in contact with oxygen are subject to oxidation which results in thickening, acid formation and eventually bearing corrosion. These additives trap oxidation free radicals before they can do further damage.

D) Rust and corrosion inhibitors

Although we might expect lubricants to prevent rust and corrosion of metals by water, they don't actually do it very well, especially if there is any acid, salts or alkalis present. On machine tools lubricants can easily be washed away by water based cutting fluids, because they contain surfactants. I'm sure you know the signs. We remove a fixture such as a machine vise only to find its base and the table

under it to be discoloured or lightly rusted. Inhibitors of this type are usually film forming amines although good old lanolin (sheep sweat or wool grease) can be pretty effective in the workshop. Lanolin was always recovered from Bradford sewage works because of the high incidence of wool scouring that went on locally.

E) Detergents and Dispersants

These are mainly used as crankcase additives to clean up combustion debris and keep it suspended in the oil. They constitute the biggest single additive component by weight in a crankcase additive package. These high levels aren't called for in workshop lubrication but are very important in historic motor vehicle lubrication. When high sulphur fuels were the norm the additive package often contained both ashless and ash containing detergents and dispersants to neutralise the sulphuric acid that blew by the piston rings into the sump. With low sulphur fuels only NOX has to be dealt with.

F) Demulsifiers

Water can get into lubricants and become trapped as emulsions which are then detrimental to lubrication and hydraulic performance. Usually only low levels of demulsifier additive is required. Remember rocker box cover mayonnaise?

G) Anti Foams

Air entrained in lubricants is especially detrimental in hydraulic oils but can easily be prevented with low levels of anti foam.

H) Extreme pressure additives. EP or anti wear

These additives usually contain Sulphur, Phosphorus or Chlorine in chemical compounds that decompose at moderately high temperature. The EP additives break down and the by-products then attack the metal's surfaces creating wear resistant compounds. Since wear produces high temperatures, these additives just react at the wearing points of contact, e.g. at the asperity to asperity contact points. When the EP action is triggered a microscopic scar is formed on the metal surface and the measurement of the size and placement of this scar is the basis of several laboratory tests to evaluate the effectiveness of EP additives. E.g. the Shell 4 ball tests and the FZG gear tests. Google these subjects should you want to know more.

The classic, and commonly used, EP additive ZDDP (zinc dialkylthiophosphate) can cause problems poisoning catalytic converters and has been reduced in many modern motor oils. ZDDP has been around for at least 60 years and is a very cost effective additive. This comparatively recent reduction in ZDDP in modern engine oils causes rapid wear problems in older classic cars that were designed when high levels of ZDDP were the norm.

Many blenders have recognised this change and have made a business of supplying lubricants for older machines and vintage vehicles, even steam vehicles. See Morris Lubricants (ref 6). Penrite (ref 7). Castrol Classic (ref 8). Of course they are using modern SN oil base stocks but add back some of the functionality missing or reduced in current lubricants by the careful use of additives.

Synthetic and semi-synthetic lube Oils

There comes a point when it is more economical to break (crack) crude oil fractions down into small molecules that can then be chemically re-combined to yield closely tailored base oil than to continue refining conventional distillate fractions. Examples of this synthetic lube oil are Poly alpha olefins. (PAO). These synthetic base stocks have some limitations and are often blended with conventional base stocks to become semi-synthetics.

Another group of important, but expensive, synthetics are the esters and poly esters. These have been around for years as aircraft lubricants and use fatty acids mentioned earlier from natural, renewable sources. These esters can have a very high VI and excellent load bearing properties. They can often have useful boundary and lubricity properties as a bonus.

Silicones and fluorocarbons

Lubricants and greases are available where the base stock is silicone oil or fluorocarbon oil. These can have excellent high temperature properties and are very expensive and are unlikely to feature in the majority of Home Workshops: I will simply note their existence and move on.

Grease

Grease is "simply" lubricating oil that has been thickened with additions of solid fatty acid soap. Thickened oils stay in place when straight oils may be lost to the bearing surfaces, e.g. a roller bearing. The real lubricant is still the oil; the soap is present in a supporting role! Because grease tends to be a "fit and forget" lubrication solution, long service life and high quality is important. A typical formulation might be 10% soap, 80% oil (mineral or synthetic) and 10% additives. The choice of soap is important, especially the metal neutralising the fatty acid. The metal determines the upper working temperature limit of the grease. Hence lithium based soaps are inexpensive, easy to make and used for higher temperatures, say up to 150deg.C. Lithium is toxic so can't be used on food machinery. There are some greases thickened with clays or silica for high temperature use. In some applications the presence of water will destroy some grease formulations because the soap is water soluble.

to be continued...

References:

- Ref 1: <http://www.youtube.com/user/dmprusk#p/a/u/1/51Zs8iaydt0>
Or search for Thompson Friction Welding on the YouTube site.
Ref 2: http://www.engineeringtoolbox.com/friction-coefficients-d_778.html
Ref 3: <http://www.stle.org/resources/lubelearn/lubrication/default.aspx>
Ref 4: <http://www.petrochemcarless.com/>
Ref 5: [http://www.engineeringtoolbox.com/Search site for ISO VG](http://www.engineeringtoolbox.com/Search%20site%20for%20ISO%20VG)
Ref 6: <http://www.morrislubricantsonline.co.uk/>
Ref 7: www.penrite.co.uk
Ref 8: <http://www.classic-oils.net/>

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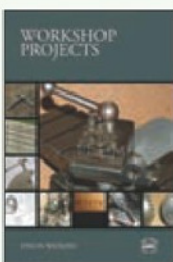


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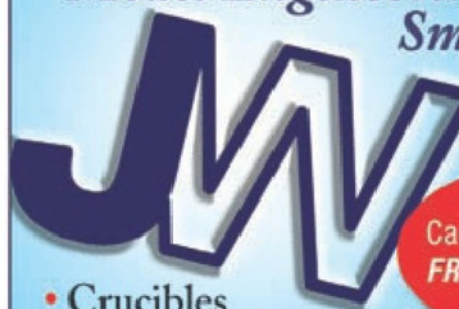
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Table 2

• (3C Collet Outer 1) • (Machine Set up - Check Diameter Mode) • G21 G18 (Metric and X Z Axis) • G61 G90 (Exact Stop and Absolute) • G95 G40 (mm per rev feed mode and off compensations) • T0101 M06 (Select Tool 1 data and do a tool change) • M03 S1350 (Start Spindle at 1350rpm) • (Place Righthand cutting tool T1 at X25 Z2 start point) • G0 X21.8 Z0 • G1 Z-67.8 F0.25 • G0 X22.5 Z0.0 • X21.3 • G1 Z-66.6 F0.25 • G0 X22.0 Z0.0 • X20.8 • G1 Z-65.4 F0.25 • G0 X21.5 Z0.0 • X20.3 • G1 Z-64.3 F0.25 • G0 X20.7 Z10.0 • M01 (Clear Swarf) • Z0.0 • X19.8 • G1 Z-63.1 F0.25 • G0 X20.5 Z0.0 • X19.3 • G1 Z-61.9 F0.25 • G0 X19.7 Z0.0 • X18.8 • G1 Z-60.7 F0.25 • G0 X19.3 Z0.0 • X18.3 • G1 Z-59.5 F0.25 • G0 X19.3 Z10.0 • M01 • Z0.0 • X17.8 • G1 Z-58.4 F0.25 • G0 X18.3 Z0.0 • X17.3 • G1 Z-57.2 F0.25 • G0 X17.8 Z0.0 • X16.8 • G1 Z-19.3 F0.25 • G0 X17.3 Z0.0 • X15.9	• G1 X16.8 Z-0.43 F0.25 • G0 Z0.0 • X15.22 • G1 X16.8 Z-0.78 F0.25 • G0 Z0.0 • X14.51 • G1 X16.8 Z-1.13 F0.25 • Z-15.42 • X16.3 Z-15.67 • Z-19.03 • X17 Z-19.38 • G0 X16.3 Z-15.67 • G1 X15.8 Z-15.92 F0.25 • Z-18.8 • X17 Z-19.4 • Z-56.5 • X22.12 Z-68.56 • G0 Z10.0 • M01 (Clear swarf) • Z0.0 (Rough Profile 0.2mm deep) • X13.94 • G1 X16.4 Z-1.21 F0.25 • Z-15.34 • X15.02 Z-16.03 • Z-19.0 • X15.67 • X16.6 Z-19.46 • Z-56.52 • X21.73 Z-68.58 • Z-74.0 • X22.0 • G0 Z5.0 • Z0.0 (Cut final profile 0.1MM Deep) • G1 X13.8 F0.10 • X16.3 Z-1.23 • Z-15.32 • X14.91 Z-16.0 • Z-19.05 • X15.63 • X16.5 Z-19.48 • Z-35.0 • X16.48 • Z-56.337 • G02 X16.442 Z-56.460 R0.4 F0.1 • G02 X16.562 Z-56.671 R0.4 F0.1 • G1 X21.63 Z-68.59 • Z-74.0 (end of profile) • G0 X23.0 • Z0.0 • M01 (Check diameter, should be 16.57 or 16.58 for "spring")	• (Repeat Cut final profile 0.0MM Deep) • G1 X13.8 F0.05 • X16.3 Z-1.23 • Z-15.32 • X14.91 Z-16.0 • Z-19.05 • X15.63 • X16.5 Z-19.48 • Z-35.0 • X16.48 • Z-56.337 • G02 X16.442 Z-56.460 R0.4 F0.05 • G02 X16.562 Z-56.671 R0.4 F0.05 • G1 X21.63 Z-68.59 • Z-74.0 (end of profile) • G0 X25.0 • Z3.0 • M05 (Threading) • T0303 M06 (Select 60deg Threading tool, 0.06mm tip rad) • G0 Z3.0 • X16.3 • M03 S400 • G76 X15.3 Z-16.5 Q2 P0.977 J0.03 H0.03 I29 C0.1 B0.01 • G0 Z3.0 • X25.0 (Drill 13.0 dia by 55 deep) • (Move Tailstock well out the way) • (Move to safe tool change position by hand) • M05 • T0202 M06 (Short Boring Tool T2) • M03 S800 • G0 X12.9 • Z-0.4 • G1 X13.0 F0.05 • X13.8 Z0.0 • G0 Z3.0 • X22.0 • M05 • T0404 M06 (Select Parting Tool T4 2mm thick) • M03 S280 • G0 Z-74.0 • X25.0 • G1 X0.0 F0.02 • X25.0 F0.25 • G0 X25.0 • Z3.0 • M05 (Stop Spindle) • M30 (End and Rewind)
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First, we will just deal with 1) before moving on to the rest of the parts, then return to complete the collets.

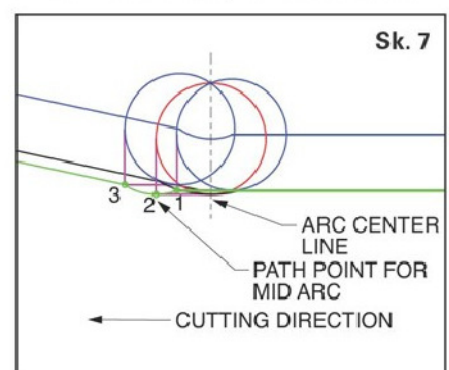
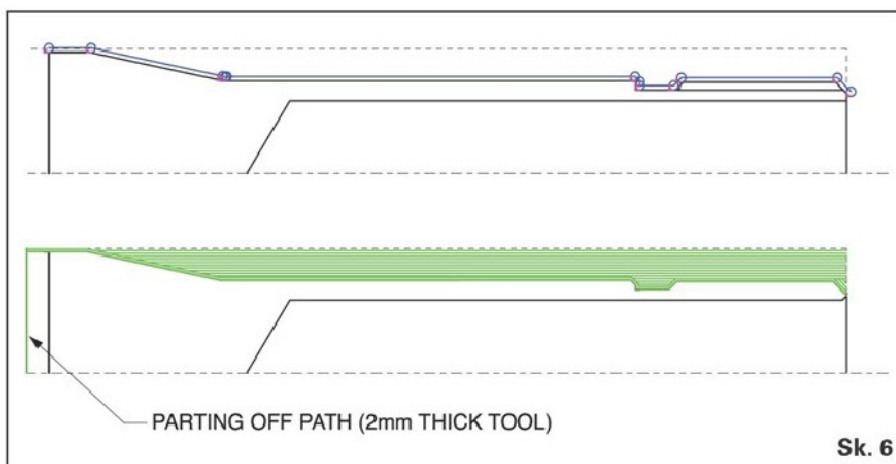
Sketch 6 shows the part profile, the offsetting and the resultant G-Code path following the process previously described. **Table 2** gives the G-Code. You will note the cutting depth is quite a bit

less than with the MT2 taper in EN1a. I've reduced the depth and increased the feed rate as this gave a much better surface finish with EN16T. I've also added a "spring cut" on the final profile at the same depth. This actually removed about 0.08mm dia yet still gave a good finish. You will see later how I suggest you set up

the tool so as to end up at the correct diameter taking account of the flexibility in the whole system.

The G-Code has three new features: two arcs at the base of the taper undercut (see drawing 3), threading and parting-off plus it requires four cutting tools.

Sketch 7 zooms in on the arcs. You can see that the blue 0.4mm offset line follows the profile and now contains an arc. If we place the cutting tip's nose radius "circles" on the blue line end points and resultant





cutting tool program coordinates (magenta lines as described previously) you get the C-Code end points as before.

Now, it's good practice to split the blue arc into quadrants to end up with two arcs. Draw another nose radius "circle" at the quadrant point (180 deg point), which is shown in red, and draw its resultant cutting tool point (magenta lines).

You now have points 1, 2 and 3 and you can draw the green arc between them using a 3 point arc. This will have the same radius as the blue arc, which is the arc of the material path, less the nose tip radius, which is therefore 0.4mm. We need this for the G-Code.

The arc from points 1 to 2 is clockwise, and so we use G2. The previous straight line has taken us to the start point of the arc so the G2 command only needs the end point and the radius to complete the move. This is done with G02 X16.442 Z-56.460 R0.4 Notice the three decimal places. Don't round when it comes to arcs or you may get into trouble with it not able to calculate the path.

The arc from points 2 to 3 is also clockwise and is done with G02 X16.562 Z-56.671 R0.4 Actually MACH3Turn is good enough not to need this arc split in this way. It can calculate that the arc is passing through the quadrant point, so strictly speaking we could just use this last G2 command from the straight-line end point. However, arcs tend to cause quite a few difficulties on more complex parts than this, and this method seems to make it more reliable. Try both ways and see how you get on. Section 10.7.3 of the manual gives you more info and shows you other ways of using arcs and the limitations you should obey.

The threading process is wonderfully simple in CNC. The controller takes care of everything for you. You just tell it a few basic facts and off it goes. To write the G-Code for this, use the G76 command as described in section 10.7.18 of the manual and take the dimensions straight from the drawing.

You end up with:

- G0 Z3
- X16.3
- G76 X15.3 Z-16.5 Q3 P0.977 J0.03 H0.03
- I29 C0.1 B0.02

The G0 Z3 positions the tool at a distance 3mm from the end of the work and at the crest diameter. This is important. The

3mm away in Z is to allow the tool to synchronise with the spindle before it reaches the start of the thread. X16.3 is the starting diameter of the thread.

Then for G76: X15.3 is the thread root diameter, Z-16.5 is the end of the thread (absolute dimension, not relative to starting point), Q3 is the number of spring passes with no in-feed, P is the pitch, J0.03 is the minimum depth of each cut (see caution later), except the first and last. H is the depth of the first cut, I is the in-feed angle (so you can cut mostly on the left cutting face of the tool and get nice swarf rather than chatter) and C is the diametric clearance when it winds back across the thread. B is the depth of the last cut before the spring passes.

Unlike threading on a manual lathe, it's possible to use a reasonable spindle speed so I set this to 400rpm, which worked well. However, a word of caution: with versions of MACH3Turn before "R3.042.026" there seems to be sensitivity to the spindle slowing during the cut which results in a strange X axis motion. This has now been fixed in subsequent versions.

Parting is simply the furthest left green line in Sketch 6, which has an allowance

for the fact that the parting tool (in my case) was 2mm wide and was set up in the lathe just like a normal left side cutting tool. You may need to change the Z position of the parting line if your tool is not 2mm wide.

Note, during the roughing out, you do not need to bother with the arc as shown in Sketch 8.

Machine setup and air-cut testing the g-code

The machine setup now has to include four tools and it is a good idea to label the tools and keep them in their holders if you have enough, as their setup will only change when they wear. The objective is to set up the tools such that they are relative to tool 1. Therefore, if you switch the machine off with no homing facility, when you return, you can just put tool 1 back, set that up correctly and the other tools will also then be correct to the work piece.

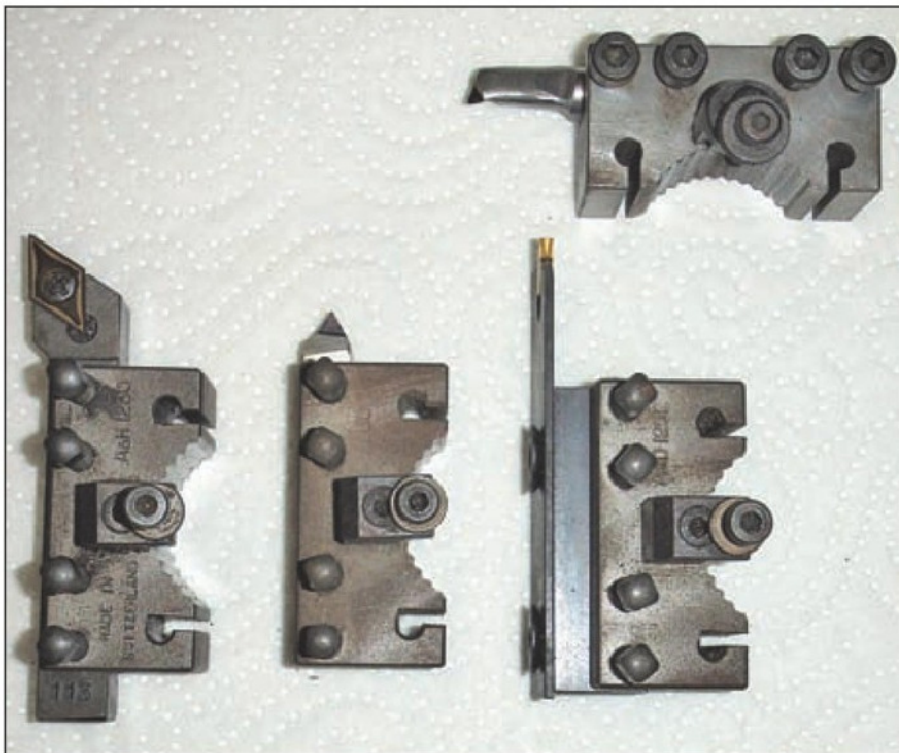
To do this, first we need to be sure the Tool Table entries for tool 1 are set to zero. Do this by going to the "TOOL TABLE" mode screen and click on "Tool Table Editor" button and check the tool 1 row is all zeros. Note also that tool 0 is effectively also all zeros (ignore it if you have random numbers in the table heading). You will see later "tool 0" is a useful feature.

The CNC lathe "coordinates" concept is a little difficult to get your head around. Basically, the machine itself has "machine coordinates" which is where the Z and X axis are in absolute terms. With a stepper motor system, this is meaningless unless we have accurate homing switches so that the machine can move to a fixed position on each axis, confirm its position and set the "Machine Coordinates". (You can actually do this by hand if you do not have homing switches.) MACH3 then knows the exact absolute position of the machine.

Then, relative to this position, we have "Program Coordinates" and the offset between these and the "Machine Coordinates" is held in the "fixture table". The first line of this is the G54



10. Setting tool 1.



11. The short boring tool is at top right.

offset. When you are in "Manual Mode" and in "Program Coordinates" and you enter data into the X or Z DROs or you click "Zero", you are actually placing an offset in the G54 Fixture Table, which is relative to the Machine Coordinates. You can see this table in the "Config" > "Fixtures" menu.

If you set the machine up in "Program Coordinates" then the actual value of the "Machine Coordinates" doesn't matter hence homing is not a requirement, but it can make life easier. As before, I'm assuming no use of homing.

Cut the 22mm dia. stock 173mm long to allow two collets to be cut from one piece as unfortunately with ORAC, the stock will not pass through the tailstock. I set 79mm projecting from the chuck.

In "Manual" mode and "Program Coordinates", set up tool 1 as before, cutting a 21.80mm dia for 3mm or more and making sure MACH3 knows tool 1 is in the tool holder at the time. Use the "Zero" axis button for Z when you are facing and type in the measured diameter in the X Axis DRO when you are turning (**photo 10**). Do this tool setting as accurately as you can. You have now set the G54 offset between the machine, the workpiece and tool 1 with zero tool 1 offsets.

Now put in tool 2, the short boring bar as in **photo 11**. Go back to the start screen and select "TOOL TABLE" mode and jog to the end of the stock. To help with this, push the TAB key and the jog screen will appear from the right, where you can set "STEP" jog (Control+J) and set the step distance to 0.01mm (Alt+J). That way you can step gently towards the end of the stock one key press at a time and watch it touch (or use your MPG if you have one). Now check Current Tool is +2, check that the Z axis "Part Zeroing Coordinates" DRO is zero then click the "Touch Z" button. You will see the "Z axis" coordinates go to zero and the "Z Offset" change to a number. This is effectively the relative Z offset from tool 1 to tool 2.

For the diameter, jog the cutting tip to the edge of the stock using a piece of flat material on the outer edge of the stock to just touch with the boring bar tip. Then enter the stock diameter into the X axis "Part Zeroing Coordinates" DRO and press the "Touch X" button. Now the measured diameter will go to the X axis DRO and the part offset will include the correct relative X offset from tool 1. This is not the most accurate way of doing this operation. It's best to use a bore and measure that, but for this chamfer, it is sufficient.

Note, you will see buttons labelled "Part Zero X" and "Part Zero Z" and also a big "TOUCH" button. Don't use these! They will adjust the G54 offset and the relative position of all the other tools!

Tool 3 (threading) is the same except you will have to judge the Z alignment of the threading tool tip with the end of the work piece by eye. Tool 4 is set up in the same way as tool 1. Just make sure you have told MACH3 the actual tool you are working on by using the "Current Tool" DRO and typing in the tool you are setting.

Just one thing to remember, the numbers in the fixture and tool offset tables are actual axis movements. So remember the X axis offsets are therefore radial. Diameter mode has no effect on these tables.

Now, one further subtlety that we need to think about. The lathe and workpiece are flexible, so when cutting, the workpiece will always be a little larger than expected. We need a very accurate profile diameter so we need to take account of this. One way is to set up tool 1 by making exactly the same cut depth and speed as per the final profile cutting pass. Or, as I did, measure the first part you make and put the difference between the measured part and the required size in the Tool 1 "X Offset" entry in the tool table (or you can use the "X Wear" offset). For me, this was -0.015mm, which is -0.03mm diameter and is as to be expected. It was also consistent over nine pieces. (I did

have one funny that was slightly under size...) So now, with this entry in the tool table, it's **VITAL** you set the machine up and the stock with tool 0 selected as this does not have the spring correction value. This spring offset is not necessary with the other tools.

At this point, I usually put tool 1 back in, select tool 0 in the MACH3 tool DRO and check its position on the work end by jogging to it. Repeat for all the tools selecting the correct MACH3 tool number and if all OK, put tool 1 back in the tool post, select tool 1 in Mach 3 and you are ready to air-cut. This tool setting process is quite long winded but you will get quicker at it and for making ten collets, it will start to feel worth it. Later you will see for one-offs, it's not necessary.

Go to the "AUTO" screen, load the G-Code and check the display is as expected. This is easier said than done I agree as there is lots of overlap. So, I usually check it as I type it in at logical stages, rather than leaving it to the completed file. You should be able to see the roughing, profiling, the threading, chamfering and the parting operations all in logical locations.

At this stage you can air-cut the profile by changing the G54 offset in the table as above by adding exactly 100mm to the Z axis entry. This will effectively move a "virtual" end of the stock 100mm to the right. You will have to enter G54 into the MDI in the "MANUAL" Screen to tell MACH3 to use this new entry. The Z axis DRO will be -100 if you were at zero before. Jog (to the right) to zero and you are ready to air-cut without upsetting the tool 1 setup. As you get more confident, you may not bother with this step - it depends on how expensive your tooling, stock and machine are!

Go back to the "AUTO" screen and click "CYCLE" and if it all looks OK, start the spindle and set the speed as noted in the G-Code (if not directly controlled by MACH3) and click "Start". It will ask for a tool change for T1, which you will already be ready for, so click "Start" again and watch it working. Check the feeds - it will move reasonably quickly! It will also stop at the M01 and say "Clear Swarf". This is a pause I put in as occasionally, the swarf would wrap around the work so this gives a chance to safely stop the spindle, clear it, start the spindle and then click "Start" again to continue. On the profiling, watch that the radius moves are done correctly.

Carry on and work through the tool changes, changing spindle speed as per the G-Code. It's very important you do this for the threading! Watch the threading and check that the X axis moves as expected, i.e., fixed during the cut, and that the Z axis feedrate seems correct. Parting will seem very slow. Those feeds and speeds were the only ones that would work consistently for me with my tooling - you may need to experiment with yours - see later.

If all has gone as expected, set the G54 entry back to the original number in the fixtures table by subtracting 100mm, enter G54 into the manual MDI command, put tool 1 back in, set MACH3 to tool 1 and jog to the end of the workpiece. Everything should be correct with the DROs (give or take the spring correction for tool 1) so you are now ready to cut metal.

To be continued...

MYFORD S7 SADDLE CLAMP

Shelley Curtis overcomes a problem

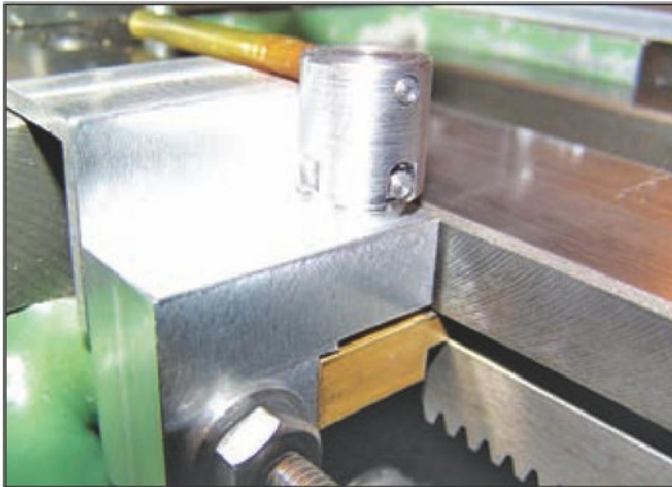


Photo 1.



Photo 2.

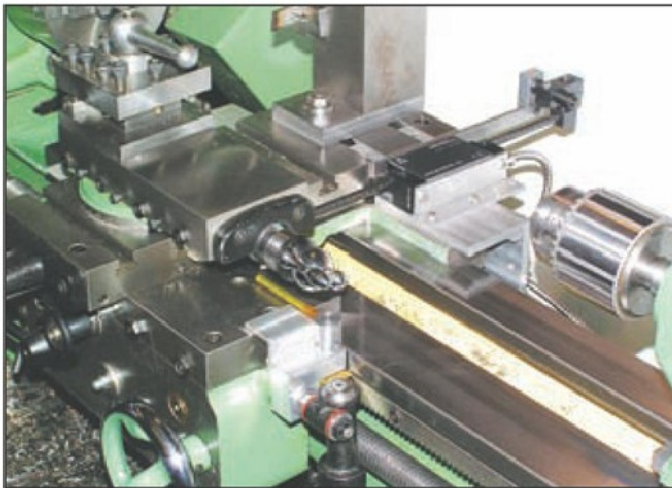


Photo 3.

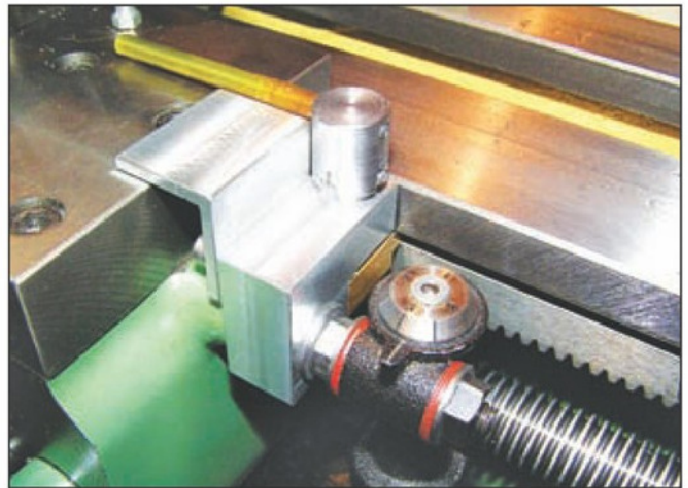
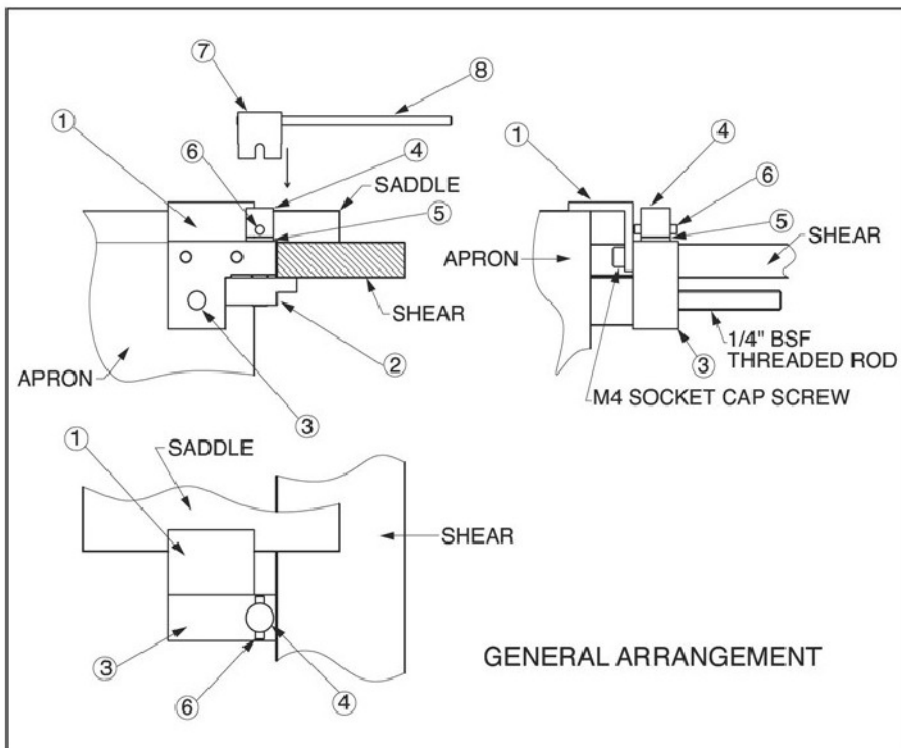


Photo 4.



Having previously fitted a Newall Microsyn DRO to my Harrison M250 I decided to do likewise to my Myford Super 7. This was achieved without "butchering" the lathe; I have always had an aversion to assaulting quality machinery with an electric drill if it can possibly be avoided!

Installing a decent brand of DRO to a Myford presents a few problems, the main one being lack of space for the scale and its attendant brackets - particularly on the cross slide. The longitudinal axis was simpler as the rear face of the bed is provided with tapped holes. The result is apparent from **photo 1**.

It will be noticed that the cross slide scale is not covered (**photo 2**). I was assured by the Newall representative that this is not essential. However, the proximity of the tailstock to the saddle is reduced by about 15mm. To avoid contacting - and possibly damaging - the DRO scale I glued a rubber block to the front of the tailstock between the shears.

As can be seen from **photo 3**, the position of the reader meant sacrificing the original saddle clamp bolt, the replacement for which is the purpose of this exercise.

The individual parts are all quite straightforward milling and turning operations and, therefore, do not merit a "blow by blow" commentary. (Sighs of relief all round!) However, just a few comments are in order.

Item 1

Bracket (Material - Aluminium Angle)

Mill the external faces to ensure a 90deg. angle and a flat surface for the Block (Item 3) to mate.

Also clean up the internal faces to mate with the ground finish on the saddle.

Assembly

Remove the thread indicator and replace its stud with a 40mm approx. length of 1/4in. BSF studding.

Fasten Block (Item 3) to Bracket (Item 1) using two M4 socket head cap screws. Do not tighten them yet.

Slide the assembly onto the 1/4in. studding up to the apron and secure with a nut and washer, ensuring that the top surface of the Block is parallel with the top surface of the saddle.

Press down on the Bracket so that it sits firmly and squarely on the surface of the saddle - if it does not then slightly elongate the 4mm holes - and finally tighten the two M4 cap screws.

Hold the Clamping Pad (Item 2) in position under the Block and insert the Clamping Bolt (Item 4).

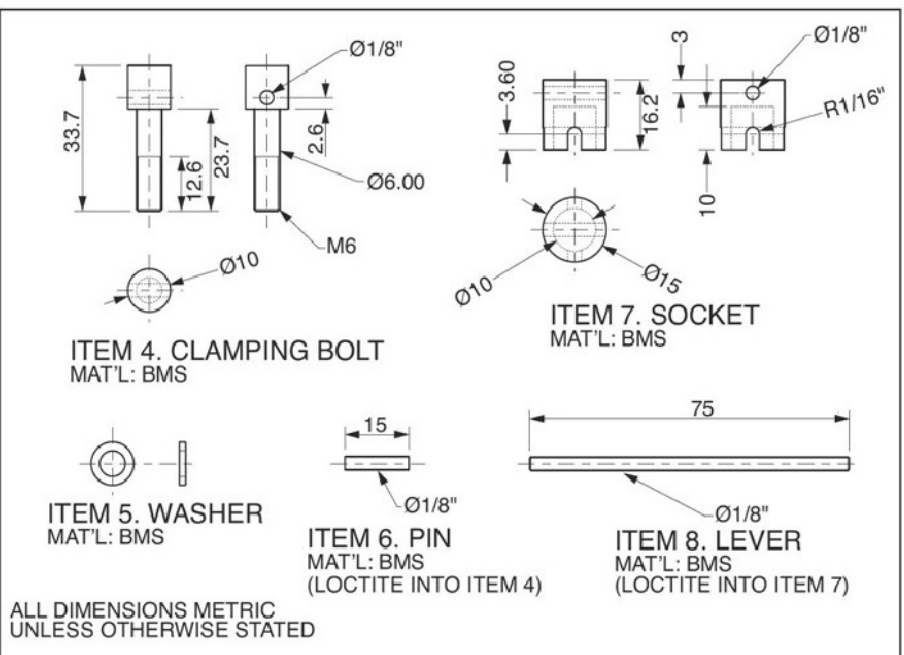
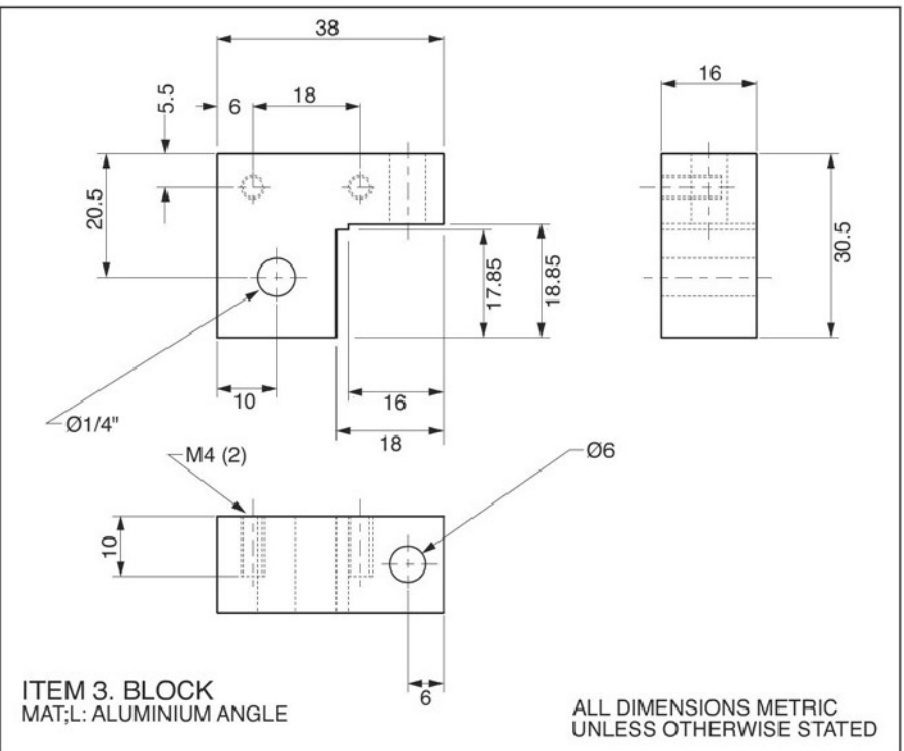
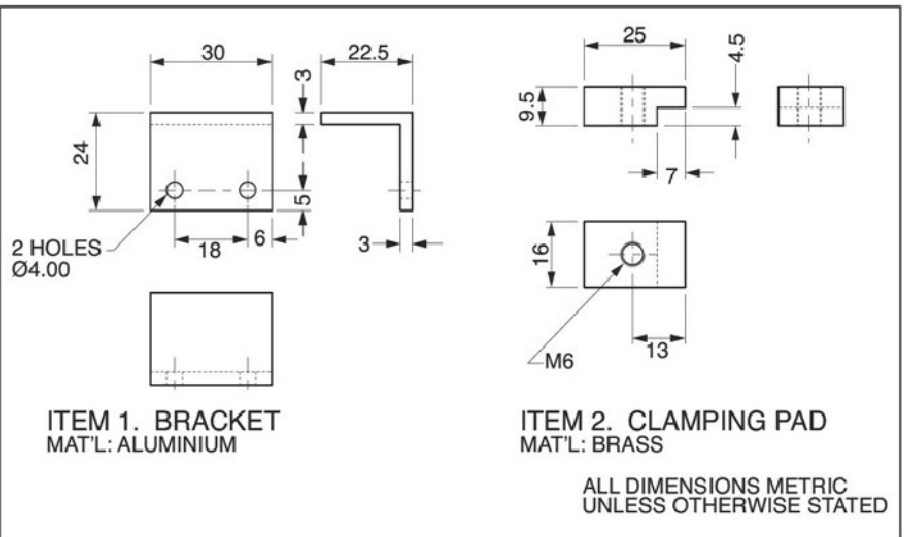
Refit the Thread Indicator - with steel and fibre washers either side - and secure with a 1/4in. BSF nut. Check that the clasp nut engagement coincides with the mark on the thread indicator. Correct by adjusting washer thickness if necessary.

Place the Socket (Item 7) - with its lever Loctited in position - onto the Clamping Bolt and check for clamping force. For cosmetic appearance a piece of 1/4in. OD plastic tubing can be slipped over the lever.

Although designed to be removable, the Socket lever presents no problem if left in situ (photo 4). As can be seen, there are alternative positions for the lever (photo 5) and the ideal setting can be attained by adjusting, if necessary, the thickness of the washer (Item 5) on a diamond lap. ■



Photo 5.



CNC MILLING, USING SUBROUTINES TO AID MACHINING OF MULTIPLE PARTS

■ OVERVIEW

Subroutines are a very useful feature of CNC programming. They let you write a routine to do a certain bit of work and then you can call this routine again and again as many times as you wish. In this article we make multiple components using component retaining tabs.

Mick Knights looks at this useful programming feature.

In a previous article, I touched on the history of NC/CNC programming. I would now like to discuss subroutines along with the temporary coordinate system offset. These aids to programming may sound a bit daunting, but once mastered are an invaluable asset to writing more complex part programmes. Subroutines, along with looping were, and still are, an essential aspect of hand written G code programmes. Any means whereby the programmer can shorten, or condense the amount of data that has to be input to construct a part program is welcome. The subroutine enables the programmer to write any number of blocks of G code, which can then be called any number of times, from the main program.

The temporary coordinate system offset will allow the subroutine, or any other designated block of programming to be executed at any position on a workpiece. This enables the machining of any number of identical features on a workpiece, or for the machining of multiple parts from one larger piece of material. The subroutine is just as useful today for the hobby machinist who fancies being a bit more adventurous with their part programming.

I have written a short programme purely for demonstration purposes and am using the Mach3 control. This is also the first time I have written a program containing subroutines for this particular control, so experienced programmers may have their own shorthand methods of constructing the G code program that might differ from my long hand version.

For demonstration purposes and for clarity, it's best to use the long hand approach. As long as both methods run and produce the required end result, all approaches have merit.

This G code part program will develop from a fairly straightforward short program, into a slightly more complex and longer one, which will allow the machining of four identical components, from the same piece of stock.

The Mach3 manual doesn't carry that much detail concerning this useful method of programming and what it has is fragmented throughout several sections. I have obtained most of the information regarding the construction of the subroutines, from the on-line Mach support forum.

Just a quick word regarding on-line forums, first of all, they are very useful and the majority of users who reply to postings are genuine and knowledgeable. I would use an angling analogy here. It very much depends on the size of the pond you're fishing in, also the bait used and of course

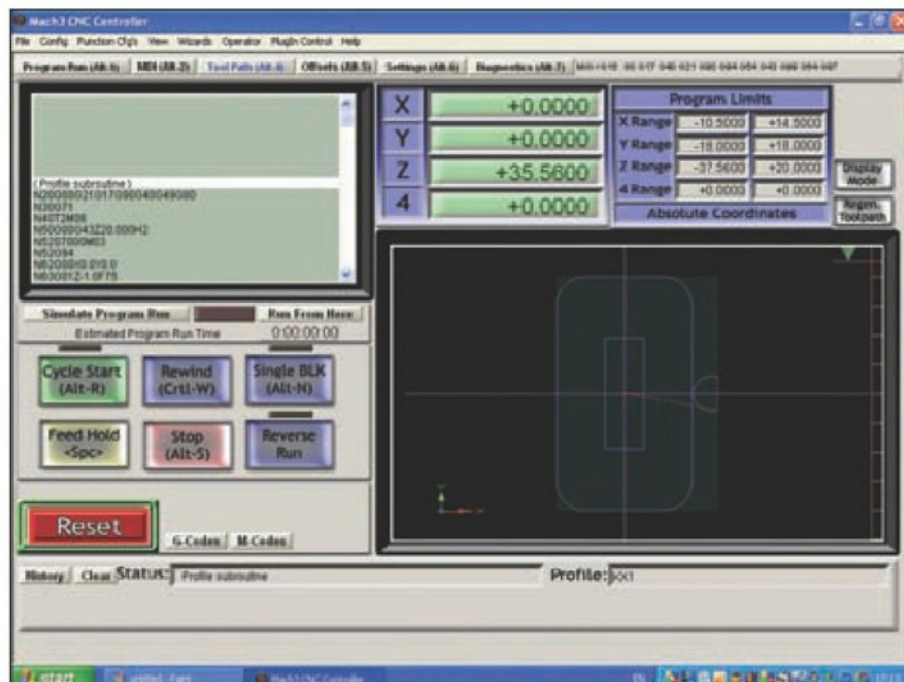


Fig 1. Tool path screen, showing component and arcing in/out feed.

a bit of luck, that the particular fish you are after swims past and takes the bait.

I have posted on a couple of sites now and have to say that in my limited experience mach support has the edge. Maybe it's beginners luck, but on all occasions my postings have been picked up by the site moderator in a matter of hours. I have also had replies from other contributors a day or two later. The replies have usually been clear and precise, but to get this response, your question also needs to be clear and to the point.

Reading other postings and replies to various technical topics in these forums, only goes to emphasize the limit of my own understanding and knowledge of this complex subject.

Basic programming rules

Unlike controls I've been used to in the past, with the Mach3 control any subroutines have to be positioned after the main program. The subroutine call and end commands, are the same as those used for canned cycles, M98 to call, M99 to close. Each sub must be allocated a number, or label, so it can be called when required during the drive cycle. This number has the prefix letter "O" followed by the label number. For example the main subroutines I've programmed are: O1001 O1002 plus an additional O1003 for the final outside profile depth cut and the machining of component retaining tabs, which I will discuss a little later on. These labels must be placed at the

head of the subroutine. No other letter or symbol must be written on the same line as the label. The line must not have an N block number. The only information allowed on the same line, is the subroutine title and this must be contained in brackets, i.e. O1001 (pocket subroutine).

When calling a sub, the letter "P" is the prefix, so the call command should be written as P1001 P1002 P1003 etc. Any Z- feed moves need to be written in the line prior to the subroutine being called. i.e.

- N50G01Z-1.5F90
- M98P1001
- N60G01Z-3.0F90
- M98P1001

The M98 sub call, along with the M99 subroutine close also need to be on a line without an N block number.

A program can contain as many subroutines as the operator requires to accomplish the finished component. Subroutines can contain, or be, canned cycles. If this all sounds a bit confusing, I hope it will become clearer, once you have read the program itself.

For this example the material used is 3mm thick aluminium. The depths of cut are in 1mm increments; this is purely to demonstrate multiple Z- feed moves in the main program. The operator would probably favour a larger diameter cutter and a single pass if this component were to be produced in the workshop.

The component comprises of a through pocket 20mm x 9mm and an outside profile 30mm x 18mm with 3mm radiused corners. To achieve a smooth outside profile, the cutter is fed in and out, on an arcing tool path (fig 1). A 3mm centre cutting end mill is to be used for all machining operations.

Program construction.

Programs written for the Mach3 control do not require N block numbers but it's a good idea to include them as it's easier to locate a particular line of program should there be a need for editing when proving the final program. It's also a good idea to number the blocks in increments of ten. That way it's a simple matter to insert extra lines if required, as the program evolves.

The program below is to produce one item. Later we'll discuss how easy it is to make as many components as you like, simply by introducing a little extra programming.

This component is having the outside profile cut complete in one operation. In normal circumstances, it would need to be retained by means of a screw or clamp secured through the previously machined central pocket. This would allow the profile to be fully machined from a larger piece of stock material in one operation. I intend to machine retaining tabs to both ends to facilitate safe removal of the first completed component, before moving on to fully machine the second. An extra sub O1003 will be called for this operation.

The Main G Code part program

- N10G00G21G17G90G40G49G80
- N20G71
- N30T2M06
- N40G00G43Z10.0H2
- N50S7000M03
- N60G94
- N70G00X0.0Y0.0
- N80G01Z-1.0F90
- M98P1001
- N90G01Z-2.0F90
- M98P1001
- N100G01Z-3.4F90
- M98P1001
- N110G00G90Z2.0
- N120G00X14.5Y-2.5
- N130G01Z-1.0F90
- M98P1002
- N140G01Z-2.0F90
- M98P1002
- N150G01Z-2.8F90
- M98P1002
- N160G00G90Z2.0
- N170G01Z-1.0F90
- M98P1003
- N180G01Z-2.0F90
- M98P1003
- N190G01Z-3.4F90
- M98P1003
- N195G00X0.0Y0.0Z6.0
- M90
- M30
- %
- O1001
- N200G00X0.0Y0.0
- N210G01X3.0Y0.0F100
- N220X3.0Y8.5
- N230X-3.0Y8.5
- N240X-3.0Y-8.5
- N250X3.0Y-8.5
- N260X3.0Y0.0
- N270G00X0.0Y0.0Z2.0
- M99

- O1002
- N280G2X10.5Y0.0I14.5J0.0F100
- N290G01X10.5Y13.5
- N300G03X6.0Y18.0I6.0J13.5
- N310G01X-6.0Y18.0
- N320G03X-10.0Y13.5I-6.0J13.5
- N330G01X-10.0Y-13.5
- N340G03X-6.0Y-13.0I-6.0J-13.5
- N350G01X6.0Y0.0
- N360G02X14.5Y2.5I14.5J0.0
- N370G00Z2.0
- N380X14.5Y-2.5
- M99
- O1003
- N390G2X10.5Y0.0I14.5J0.0F100
- N400G01X10.5Y13.5
- N410G03X6.0Y18.0I6.0J13.5
- N420G01X2.0Y18.0
- N430G00Z-2.7
- N440G01X-3.5Y18.0
- N450G01Z-3.4F90
- N460G016.0X18.0F100
- N470G3X10.5Y13.5I6.0J13.5
- N480G01-10.5Y-13.5
- N490G3X-6.0Y-18.0I-6.0J-13.5
- N500G01X-2.0Y-18.0
- N510G00Z-2.7
- N520G01X3.5Y-18.0
- N530G01Z-3.4F90
- N540G01X6.0Y-18.0F100
- N550G3X10.5Y-13.5I6.0J-13.5
- N560G01X10.5Y0.0
- N570G2X14.5Y2.5I14.5J0.0
- N580G00Z2.0
- N590X14.5Y-2.5
- M99

Blocks N10 to N195 are the main drive program, which include the subroutine call lines M98P1001 M98P1002 and M98P1003.

All Z- feed moves have been programmed prior to the M98 call command line.

Blocks N200 to N270 contain the through pocket subroutine program. The last G move of the sub must return the cutter to its starting position prior to the next Z-feed move being called. The M99 command will close the sub.

Blocks N280 to N380 contain the outside profile program, to a Z- depth of 2.8mm. This is all reasonably straightforward, so far.

Blocks N390 to N590 contain the subroutine to machine the component to finish depth, along with blocks N420 to N460 and N500 to N540 which are the Z moves which will produce the retaining tabs.

Multiple Part programming

If several identical parts are required, then they can be machined from one piece of material, simply by shifting the X0 Y0 absolute zero point, in either a plus or minus, linear or angular direction, as required. The program above would only need slight modification to achieve this.

First of all, the program parameters need the inclusion of G54 (Select work offset coordinate system) So block N10 Would now read:

- G00G21G17G90G40G49G80G54

The manual does state, that it is an error to use G54 to G59 if cutter radius compensation is on.

The temporary Coordinate system offset G52 needs to be inserted into the start of the main drive programme. So blocks 40 to 50 will now read:

- N40G00G43Z10.0H2
- N45G52X0.0Y0.0
- N50S7000M03

This will allow the subroutines to start at the X0.0 Y0.0 absolute zero position, for the first component. Once the machining cycle is completed and one component has been successfully produced, the start position for the second component needs to be re-positioned at X-22.0 Y0.0. This will leave 1mm of material to be machined from the first face of the profile. The first operation is to machine the through pocket of the second component. After which a program pause and spindle stop will be called to allow the safe removal of the first component, which is now held by its retaining tabs. The cycle is restarted by clicking START so the programme at block 195 should now read:

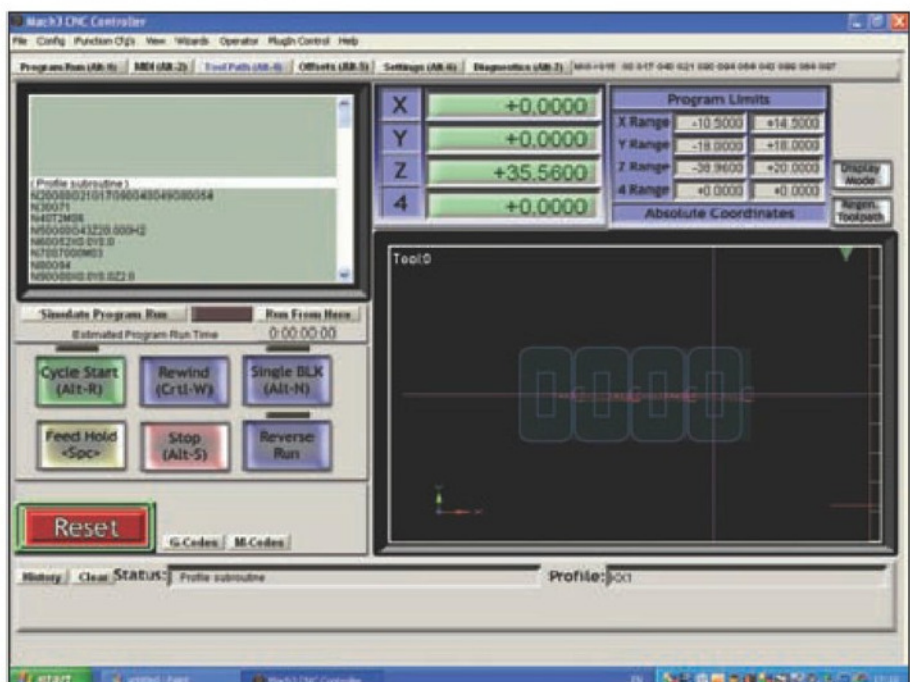


Fig 2 Graphics screen showing four multiple parts programmed.

- N195G52X-22.0Y0.0
- N196X0.0Y0.0
- N197G01Z-1.0F90
- M98P1001
- N198G01Z-2.0F90
- M98P1001
- N199G01Z-3.4F90
- M98P1001
- N200G00Z6G90
- M5
- M0
- N210S7000M3

All the Z- depths and subs are programmed in the identical way as the previous main program, until the last call of the M98P1003 subroutine is reached. The shifted start point then needs to be returned to the original X0 Y0 absolute zero point, so as the next shifted start position can be made in absolute mode. This movement doesn't actually physically occur; it's only for the control to orientate itself. So at this point the next line should read, along with the appropriate N block number:

- G52X0.0Y0.0
- G52X-44.0Y0.0
- X0Y0
- G01Z-1.0F90
- M98P1001
- G01Z-2.0F90
- M98P1001

The program pause and restart for the other identical components should be written at the same point in the extended program as shown in blocks N195 to N210, that is, after the machining of the through pocket P1001.

The process can be repeated as many times as required. (Fig 2)

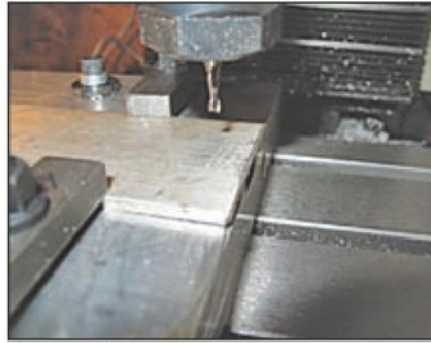
Any section of program can be shifted to run at a different set of ordinates, at any position on the workpiece, simply by using the G52 temporary coordinate system offset, in the same way as demonstrated above. The section of programme to be shifted doesn't have to be contained within a subroutine. The G52 application is cancelled by the G52X0.0Y0.0 line.

Retaining tabs

A useful inclusion into any programme for a through pocket, or for a profile to be cut out of a larger piece of material, is a couple of retaining tabs. These are thin sections of service stock left behind, after the final cutter pass, which will hold the slug of material from the pocket machining, or the component itself, in position, thus avoiding any damage to the component, or the cutter, on final cutter breakthrough at the end of the machining operation.

These tabs need only to be about 0.2mm thick and around 3mm wide, depending on the size of the slug, or final component. The tab only takes a few extra lines of program and is ideal for including in a subroutine. The component retained by the tabs, can be easily snapped free, once the machine has stopped. An optional spindle stop and program pause command should be included for safe removal of the component. The remaining portion of the tab can then be lightly filed off the finished job.

The sub O1003 is called to cut the final pass of the outside profile of the component. This needs to be a separate



1. The initial setup.



3. With the first component removed, the outside profile of the second component is ready to be machined.



5. The outside of the third component is complete.

subroutine, as several Z moves are required to create the tabs. All the other subs run on Z minus moves programmed prior to the individual sub call. These are known as variable Z depths and are mainly used to machine several Z passes at different depths on a single feature. Any number of Z moves can be programmed within a subroutine if required.

The last command of the main program will cancel the G52 temporary coordinate system offset and return the cutter to the initial start point at X0.0 Y0.0.

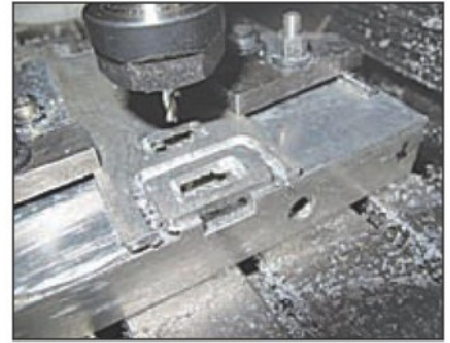
G52 is cancelled as below:

- G52X0.0Y0.0
- G00X0.0Y0.0Z0.0

Proving the program

A strip of 3mm thick aluminium was clamped to a sub base (photo 1) and the cutter zeroed centrally about the workpiece and 11mm in from the outside edge.

The first component was fully machined and retained in position by the two tabs of service stock. The through pocket of the second component is also machined on this cycle. With the program paused and



2. Programme paused, to allow the removal of the first component.



4. Milling the centre of the third component.



6. Cutter returned to the initial start position.



7. The finished component, with retaining tabs.

the spindle stopped, the first component can be safely snapped free from its' retaining tabs (photo 2).

When the first component has been removed, the program can be re-started to fully machine the outside profile of the second component, along with the through pocket of the third (photo 3).

The process is repeated, until the fourth and last component has been fully machined (photos 4 and 5).

The final command of the main program is called and the cutter is returned to the initial start position (photo 6).

Photograph 7 shows a finished component with its retaining tabs yet to be filed off. ■

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A SIMPLE SUB-TABLE FOR THE KX1

Mick Knights adds a work holding plate to his KX1 CNC mill

OVERVIEW

A sub table functions in three ways, it protects the machine table from inadvertent crashes if you have a programming error, it enables you to clamp work that might be too large or irregular to fit a machine vice and it raises the work up enabling shorter cutter lengths to be used.



1. Cutting the sub-table blank from a plate of aluminium.

I've been putting off making a sub-table for my KX1 mill for some time now, as other projects have always seemed to take priority. But now I really could do with one, as quite a few components I've been producing of late needed to be clamped flat to the machine table, which, if using small diameter cutters, puts them at, or beyond the Z travel of the machine. The sub-table will have the effect of lifting workpieces a further 30mm off the machine table, which will then be within the range of most of my smaller diameter cutters.

Normally a sub-table would be produced from cast steel or a similar robust material, but as only light machining is undertaken on this mill, a sub-table made from 20mm thick aluminium will be quite adequate. But this does mean sacrificing my last decent piece of aluminium plate to the cause (photo 1).

The exact dimensions of any sub-table will very much depend on the material available, but ideally, the size of any billet used should be greater than the table movement in X and Y. Once the billet was cut from the larger piece of plate, it

needed to be squared up all round and this was done on the conventional mill. The billet also needed to be re-positioned on the machine table, to allow the cutter to machine the entire face in one unbroken pass. The freshly machined face was located against two removable tenon blocks (photo 2) and the billet clamped down, clear of the table, on packing pieces. Tenon blocks need to be a close, tap fit in the table tenon slots, this is to ensure positive location of the workpiece square to the spindle.

The front face was machined in one pass, using a fine pitch 12mm diameter ripper end mill (photo 3). The back face was also machined parallel on the same setting (photo 4).

To machine the end faces square to the existing sides, first position and fully tighten a third clamp, before releasing the end clamp thus avoiding any chance of the billet moving while the clamping point is altered (photo 5). The end face can then be machined square to the two parallel sides, and the process repeated on the other end (photo 6).

While the billet is clamped to the table, all hole positions for the clamping feet can be pitched out and centred. The positions for two dowel pins, which will locate the sub-table square to the KX1 machine table, along with the position of the table central reference point, are pitched out and centred at this time. Both the dowels and the reference point, sit on the central axis of the sub-table. A hardened bush will be fitted into a reamed bore at the precise centre of the sub-table. This will be used



2. Re-positioning the table billet for machining square.



3. Front face machined.



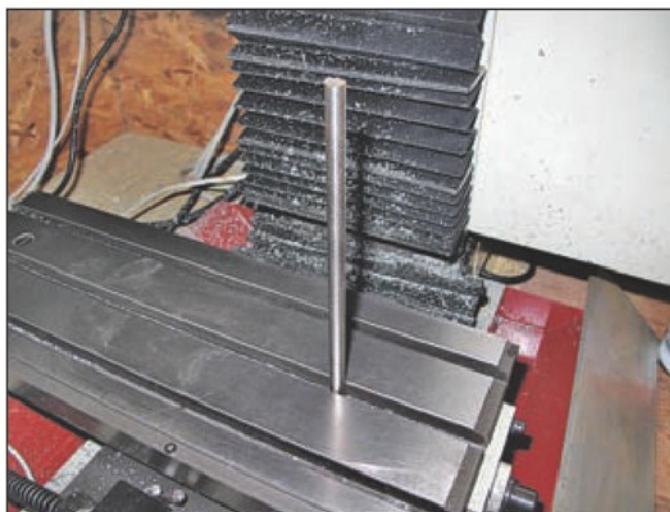
4. Rear face machined parallel.



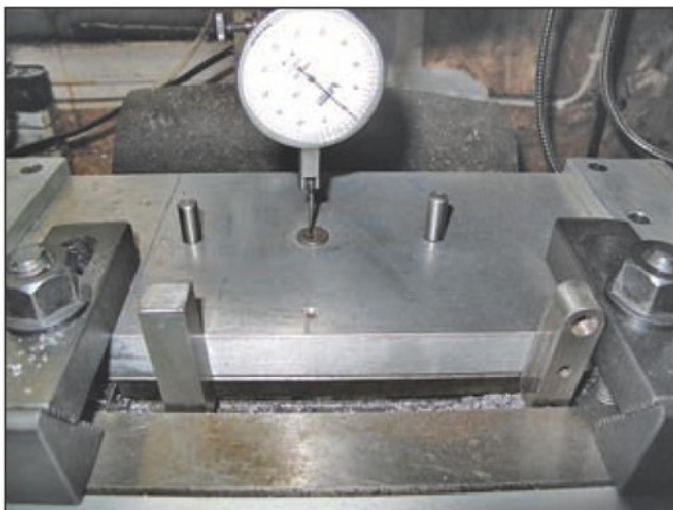
5. Third clamp in position, before releasing end clamp.



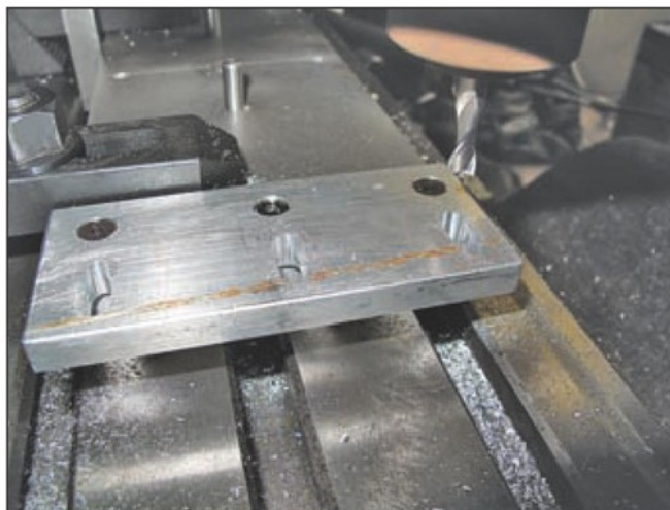
6. End faces machined square.



7. The KX1 table tenons gauged with 8mm dia. silver steel.



8. Picking up the central table position using a DTI.



9. Machining the clamping slots.

as a zero reference point, so any fixtures and locating nests to be used in the future, can be quickly re-established from coordinates referenced from this point.

As well as saving programmes in files on the computer or on removable disc, I always keep a final print out of any proven complicated programmes that I might need to run again in the future. Any clamping or locating holes machined in the sub-table to aid the production of the component have their coordinates, relative to the central zero position, recorded on the print out.

To establish the exact width of the tenons, in which the dowel pins will locate the sub-table, the tenon slots were gauged with drill shanks, until a close fit was obtained. The tenon slots were gauged at 8.0 so 8mm diameter silver steel is the ideal material for the dowel pins (photo 7). If the dowel pins aren't a completely snug fit in the tenons, then simply push the dowels tight against the machine tenons when tightening the sub-table in position. This will have exactly the same locating effect.

Two pieces of 50mm x 10mm aluminium flat bar are used as clamping feet for the sub-table. Hole centres were pitched out on the conventional mill to correspond with those already centred on the sub-table billet. The feet were drilled 5.2 dia. and countersunk to accept M5 countersunk socket head screws, while the underside of the sub-table was drilled and tapped M5 to a depth of 10mm.

Clamping slots now needed to be cut into the clamping feet, which will line up with the KX1 table tenons. Once again

the sub-table was located squarely against the tenon blocks and the exact centre position picked up using a DTI (**photo 8**).

The KX1 table tenon centres were measured at 45mm. Using a 7mm dia. slot drill, three slots 15mm long were machined relative to the centre line in both feet (**photo 9**).

The assembled sub-table now needed to be positioned on the KX1 mill, with equal table movement either side of the spindle. First position the sub-table by eye on the machine table and establish X0 Y0 by using a DTI around the hardened bush that is fitted centrally in the table (**photo 10**). Jogging the machine table in 0.001 increments against a DTI is the perfect opportunity to check if your DTI is reading accurately.

Jog the X axis in one direction until the limit switches trip and record the reading from the DRO. Jog in the opposite direction until the limits trip. Half the difference between the two readings is the distance the sub-table needs to be manually repositioned for equal travel either side of the spindle. This can be easily achieved by taking a reading using the depth probe of a digital, or conventional vernier, with the body resting against the end of the machine table and the probe against the clamping

foot. Adjustment is made to the vernier reading to reflect the compensation required and repositioned against the end of the machine table. The sub-table can be slid to its new and permanent position central to the spindle.

When the centre of the sub-table was re-established, using the DTI around the central bush, the difference between the before and after Y axis DRO readings was 0.002mm I think that will be as accurate as I'll ever need the table to be re-located. Once the final position has been established, the location can be made permanent by clamping a register block behind one of the clamping feet (**photo 11**).

With the tenon locating dowel pins and the end register block as permanent reference points, the sub-table can be quickly removed and accurately re-positioned, to facilitate the machining of components that require a machine vice clamped to the machine table.

I also want to be able, to quickly and accurately locate and clamp a tool makers' vice to the sub-table. To this end a 1mm deep locating register, the width of the vice, was machined, at a central position.

The locating recess was machined in two 0.5mm passes, using the rectangular pocket wizard (**photo 12**) with the width of the

sub-table increased by the cutter diameter to achieve an open ended recess. 0.5mm was left on the width of the recess for final machining to achieve a smooth and snug fit between the vice and the register after the width of the first pass had been measured. Machining this recess also ensures that the toolmakers' vice sits completely parallel to the spindle (**photo 13**).

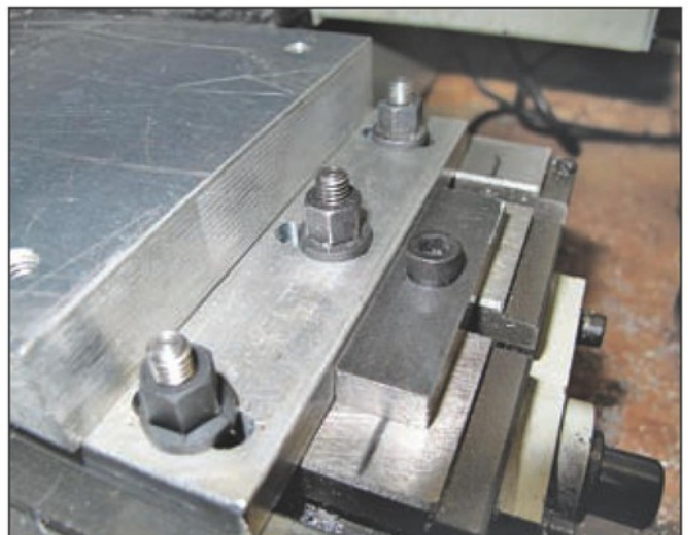
Three rows of M6 holes were produced to take the clamping studs and clamps. This is to enable the vice to be secured, fully, or partly in the recess, depending on the application.

To maintain the integrity of the table surface for as long as possible, I intend to produce any fixtures or nests that may be required, on separate pieces of thinner aluminium plate, which will be accurately located with countersunk socket head screws. Their positions will be at known coordinates from the central bush, making accurate setting quick and easy.

Ideally the entire surface of the table should be machined flat relative to the spindle. The only real way of achieving a totally flat surface, would be to fly cut the area in one pass. This is impracticable so any fixture plates used will be machined when secured in position so ensuring the accurate manufacture of all components. ■



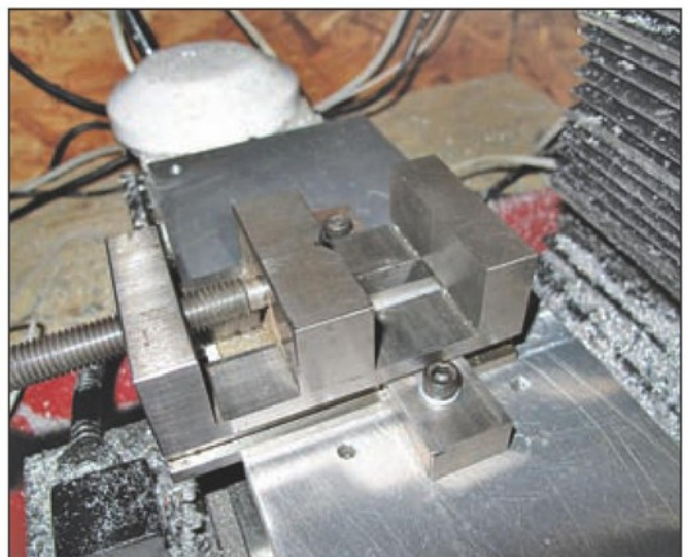
10. Picking up the central position on the KX1.



11. End register block.



12. Machining vice location recess.



13. Toolmakers vice in position.

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ESTABLISHING AND USING A TOOL LIBRARY

Mick Knights organises his tool holders

OVERVIEW

One of the most useful features of CNC machining is the ability to have a selection of your most popular cutters, set, and ready for use in a tool library. This does away with the need to establish the tool length offset every time an individual cutter is selected for a particular machining operation when using two or more cutters in a part program machining cycle, or when machining a component, one stage at a time using wizards. When using more than one cutter, it's a good idea to establish a tool change position away from the workpiece and at a Z height that will allow easy removal and installing different lengths and body diameters of the various cutters in the library.



Tools mounted in the rack.

Any program would need to be paused and re-started at these tool change positions i.e.

- G00X100.0Y25.0Z50.0
(Go to tool change position)
- M5 (Program stop)
- M0 (Spindle stop)
- T3M06 (Tool change)
- G00G43Z20H3 (Pick-up new TLO)
- S6000M3 (Spindle re-start)
- G00 X10.0Y10.0Z2.0
(Go to next coordinate position)

The Mach3 control has the capacity to store 255 separate tool length offsets, but the hobby machinist would probably only need half a dozen or so set at any one time.

There are some very good milling cutter holders available, at quite a modest cost, considering the machining and the accuracy involved in producing them. If like me you have enough sweaters and

socks to last the rest of your natural, then milling cutter holders and quick change tool holders for the lathe, make ideal birthday and Christmas presents for the man, or woman, who has everything, as you really can't have too many of either. In this way you can painlessly, over time, build up a comprehensive tool library.

To begin establishing a tool library, simply make a selection of your most useful cutters. For example, a roughing and a finishing cutter, for machining pockets. A hole centring tool (not a centre drill), perhaps an engraving tool or a number of specific tools required to complete a particular part program.

The tool length offsets of the library, (TLO) once established, will remain constant to the Z zero setting they were taken from. This means that every time a new machining set up is undertaken, the only Z zero position that needs to be re-established, is that of the dedicated

referencing tool holder, as all the offsets remain constant to it.

The Z zero position can simply be achieved by using a piece of stock bar of the same diameter as the tool holder bore and set in a spare tool holder. This can then be used every time a new set up is undertaken. I have used an old end mill shank secured in a tool holder. This has the added advantage of having the auto lock locating centre, which acts as central clearance and ensures that the end of the shank is laying completely flat against the work piece.

The Z zero setting bar needs to be longer than the longest tool intended for use. The gap between the two, will then be the Z safe working plain (**photo 1**). In this case, the gap between the setting distance piece and the longest tool is around 12mm, which is fine when holding components in a machine vice, or clamping directly to the sub-table by using



1. Ensure that the Z zero setting bar is longer than the longest tool.



2. Setting the Z zero position with a two thou feeler gauge.

cap head, or countersunk screws. If finger clamps or other work holding devices are being used, than the gap between distance piece and the longest tool, should be increased proportionally.

The setting bar is jogged down to the workpiece and the Z zero position obtained by using a two thou feeler gauge between the bar and the workpiece (photo 2). The Z zero position is then established at this point. For demonstration purposes I'm setting all the TLOs to the top face of the sub-table, but all will be quickly re-established when the reference bar is zeroed, once a new setup is undertaken.

Always ensure that there are no tool numbers and offset values displayed in the TLO window before establishing Z zero.

All the TLOs for the selected cutters can now be established from this Z zero position in the usual way (photo 3). Always check to see that all the tool positions in the TLO register have zero values before entering the new offsets. Once all offsets have been entered, the values should be stored using 'apply' in the TLO register.

These TLO values can be utilised on any other setup, once the referencing bar's zero position has been re-established, on the new workpiece.

If cutter wear or breakage should occur during machining, it's a simple task to re-establish the replacement cutter, by clearing the previous TLO in the register and setting the new one from the current Z zero point in the usual way.

I will be producing a tool rack, where the cutters of the tool library can be housed in their designated and numbered locations (fig 1). The 18.5 bores are spaced in blocks to reflect the different diameters of the tool holder bodies.

This is an ideal job to be machined on the Sieg KX1 mill, using the newly produced sub-table (see article in this issue. Ed.).

I have written an article where I demonstrated how to construct and run a sub-routine (In this issue. Ed.). Well here's a practice example of the sub-routine in operation. This program is to produce the clearance holes in the tool rack, for the Morse tapers of the cutter holders.

As the clearance holes are not that important, a subroutine using the circle cutting G12 in several depth steps would be the quickest and easiest method.

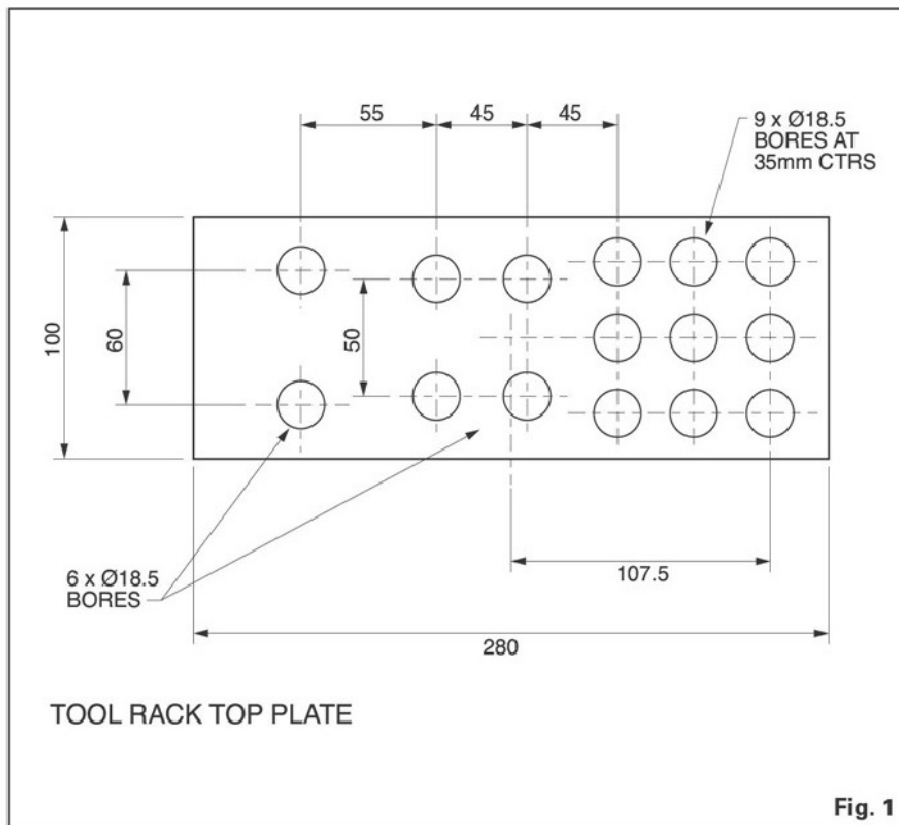


Fig. 1

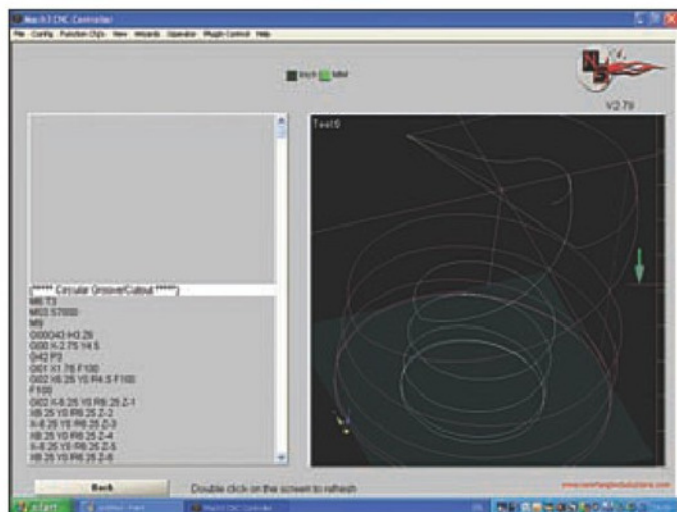
However, I'm still at the stage where I like to try out different options where available, so for the sub-routine I'm using a G code program constructed with an NFS wizard.

The cut circle wizard in the free to use section of Mach3 is a bit of a strange animal. I've only run it on the tool path graphics, but it appears to produce an offset bore, from which it feeds out and cuts the circle. This would have the effect of producing an uneven cutting action, as the cutter will encounter thin and then thicker sections of stock to remove on its' cycle.

The wizard in the NFS suite is a very clever canned cycle. This circle cutting wizard will produce a circular ramping tool path, while cutting the circle diameter itself. The pitch, or helix, can be programmed to produce as fine or coarse a feed as required (fig 2). This cycle uses cutter diameter compensation and according to the manual, there is an error

when using the G54 work offset coordinate system. (This is discussed in the sub-routine article.) A little bit of tweaking is therefore required. First edit out any reference to cutter compensation within the circle cutting cycle i.e. G42 P3 at the start & G40 at the end, (P3 is only the dwell time in seconds). This will effectively change the routine into a canned cycle similar to G12/G13 which means the cutter diameter needs to be subtracted from the bore diameter, in order to obtain the value to be entered to achieve the correct finished bore size.

The cutter selected is a 6mm centre cutting end mill so rather than entering the finish bore diameter of 18.5mm into the wizard, a value of 12.5mm needs to be entered in order to achieve the 18.5 diameter. (Required hole size, 18.5mm - 6mm cutter diameter = 12.5mm. If a size bore is required then it's probably prudent to program the diameter at 12mm so the bore can be measured and any



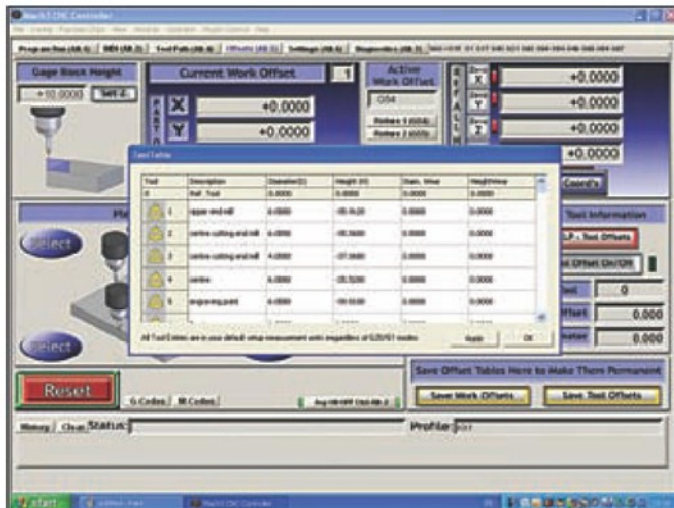


Fig 4. Tool library register, in offsets.



3. Setting longest tool (T12) with the two thou feeler.



4. Tool rack top plate in position, ready to be machined.



5. Machining tool rack top plate.

adjustments to the values made, before committing to final machining.

The posted G code program produced by the circle cutting wizard, now only needs to have its G parameters removed and the sub-routine label O1001 placed at the start. Also the M3 command is removed from the end and replaced by the sub-routine close M99.

The drive programme is a simple point to point, controlled by the G52 temporary coordinate system offset, which I discussed in the sub routine article. The modified sub-routine below is to produce the 18.5mm diameter bore at a number of coordinates around the tool rack, using the 6mm centre cutting end mill (fig 3).

- O1001
- G00Z1.0
- G00X-2.75Y4.5
- G01X1.75F100
- G2X6.25Y0R4.5
- G2X-6.25Y0R6.25Z-1
- X6.25Y0R6.25Z-2
- X-6.25Y0R6.25Z-3
- X6.25Y0R6.25Z-4
- X-6.25Y0R6.25Z-5
- X6.25Y0R6.25Z-6
- X-6.25Y0R6.25Z-6.25
- X6.25Y0R6.25Z-6.5
- X-6.25Y0R6.25Z-6.25
- G00Z6.0
- G2X1.75Y-4.5R4.5
- M99

The plate being used for the tool rack is 1/4in. aluminium, which is held clear of the sub-table by 6mm washers. The final depth pass is programmed at Z- 6.5mm to allow the cutter to just break through the underside of the plate.

The tool rack plate is secured to the sub-table by four M6 cap head screws (photo 4). These hole centres were pitched out on the conventional mill, to match the M6 threads in the sub-table, which are positioned centrally to the hardened bush in the sub-table. The program was successfully executed (photo 5).

The free to use, Write Wizard was used to engrave the tool numbers next to the bores. In a previous article I used the text



6. Engraving the tool numbers.



7. The finished tool rack.

engraving facility in the Cut2D package. This is by far the easiest method of producing a string of text but for engraving single numbers at different coordinates, the free Write Wizard is the preferred choice (photo 6).

As the numbers are positioned equal around the 18.5mm bores centre line and centrally between the bores, the coordinates are easily calculated and entered in the X Y coordinate location boxes in the wizard i.e. the first number to be engraved is at bore No. 1 which is positioned at X107.5 Y35.

With a web thickness between the bores of 16.5mm, the X coordinate for engraving the first number, is 107.5 minus half the bore and web = X90.0.

The starting position for all text and numbers is at the base of the character so with the character programmed at 7mm high, the Y position has to be 3.5mm below the bore centre line, at Y31.5

All subsequent X positions are 90mm minus the incremental hole centres, until the minus quadrant is reached, when obviously the values change to minus. All Y values are 3.5mm below their centre lines.

The finished tool rack is mounted on four ½in. dia. x 70mm long aluminium legs, secured with countersunk socket head screws (photo 7). ■

Completed program

- G0 G49G40 G17
- G80 G50 G90 G98G54
- G21 (mm)
- M6 T3
- M03 S7000
- M9
- G00G43 H3 Z6

- G00X0Y0
- G52X107.5Y-35
- G01Z2.0F300
- M98P1001
- G52X0Y0
- G52X107.5Y0
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X107.5Y35
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X72.5Y35
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X72.5Y0
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X72.5Y-35
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X37.5Y-35
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X37.5Y0
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X37.5Y35
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X-7.5Y-26
- G01Z2F300
- M98P1001
- G52X0Y0

- G52X-7.5Y26
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X-52.7Y26
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X-52.5Y-26
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X-107.7Y-30
- G01Z2F300
- M98P1001
- G52X0Y0
- G52X-107.5Y30
- G01Z2F300
- M98P1001
- G00Z10.0
- G52X0Y0
- G00X0Y0
- M30
- %
- O1001
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These basic 415 Volts output inverters come in 3 sizes from 1HP up to 3HP and they offer all the functions of the 220 Volt output version BUT the fact they offer 415 Volts output means they can be used with motors that are NOT DUAL VOLTAGE, this would often be the case on older motors or on DUAL SPEED motors.

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- 3 HP (2.2kW) £419.95



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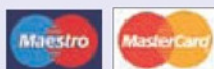
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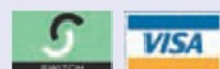
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SCRIBE A LINE

Happy subscriber and electrical danger

I read with interest the 'Phoenix Battery Drills' article by Martin Gearing. I would certainly not subject him to a flogging for connecting a 9v Drill to a 12v battery as he fears some would but I might (metaphorically) suggest it for showing his use of IEC mains connectors. I accept that Martin has moved on to Speakon plugs and I have no problem with those but there is a real danger that someone could plug a mains lead into a battery powered drill modified with an IEC socket. This has the potential to cause serious or even fatal injury. I urge you to warn your readers not to follow this example at the earliest opportunity.

John Shepherd (A continuous subscriber since issue 5)

Unhappy subscriber

I have come to the point where I will cancel my subscription for Model Engineers' Workshop. It really has hit rock bottom.

FIRST STEPS IN 3D, how many pages have been wasted on this article? All this info could be gleaned from the manual supplied with the software. What percentage of readers are interested anyway? As for Dave Fenner it's a case of how much money can I make out of this article and what can I dream up next to boost my bank balance. When it comes down to showing the difference between a 6in. and 12in. rule that is scrapping the bottom of the barrel. Hope things pick up for your sake as many colleagues feel the same as I do.

Ian Pickering. By email.

PS Be interesting to see if letter appears in scribe a line.

The editor replies: When first putting this series in, I did wonder if it was a good idea. It is relevant to many readers who are entering model engineering or home workshop activities and who have computer background. I have had more positive response to the 3D articles than I have had negative response (see letters below).

Dave Fenner does not dream up articles to fill up his bank balance. Dave has a good following and his down to earth, sometimes agricultural methods work. Dave was not showing the difference between a 6in. and 12in. rule, they were just there for illustration purposes. Most articles Dave produces are at a reader's request. A reader will write to me or phone me suggesting an article and I sometimes ask Dave, or possibly Harold Hall, if they would like to supply

Another happy subscriber

I recently received a renewal notice for my MEW subscription. I have to confess that it languished on my bench, whilst I struggled with thoughts such as 'it's only for Myford' or 'nobody else in the whole world has ever bought an EMCO' and 'only a mechanical genius with months of spare time could make that'. Then issue 162 arrived. The range and depth of the articles is impressive, from Harold Hall's usual top quality offerings, through the excellent edge and centre finding article to a useful introduction to workshop materials. More followed! Some 3D design, CNC lathe work, revitalizing old drills, engineering measurement and finally a detailed refurbishment of an old lathe.

I quickly came to my senses, filled in the subscription form and put it in the post. Where else could I get all this? I'd like to thank the authors of all the above mentioned articles, and the editor for putting such a good magazine together. I won't ask for any articles about the Compact 5, I'd only be told to write one - and quite right too!

Keep up the good work.

John Slattery, by email.

an article. Perhaps Dave would like to comment, or even supply a photo of a 3 foot rule as the 1 foot rule shown in the photo mentioned is unlikely to reach the bottom of the barrel.

First Steps In 3D Design.

I have been surprised that there have been no comments in Scribe a Line about your 3D Design serial. I can only conclude that most readers (like me) have been far too busy following the author's excellent advice (practice regularly) to put pen to paper.

When the series started I thought Christmas had arrived early, not only were we given the opportunity to acquire a high quality and expensive, 3D program for nothing, but we also had

Mr Wedlock's guiding hand to show what could be achieved with it. In his series conclusion he states that his intention was to give positive help to beginners in 3D. In my opinion this has been splendidly achieved. He has the priceless gift of being able to explain a complex subject in an easy to understand manner, his hints and tips have been invaluable.

He has taken a great deal of trouble with the examples given, and there has even been, (like the cherry on the cake) a light sprinkling of humour. Following the example of our Editor, I have found the recent winter too cold for serious use of the workshop, and this has provided a fascinating and valid modelling substitute. Now that it has ended I am having serious withdrawal symptoms, the World, and indeed, the magazine, will seem a flatter place without Mr Wedlock's extra dimension in it. I would like to thank both him and our editor for bringing us this inspirational series.

John Flanagan, Devon.

TrueSpace

When Linton Wedlock started his series some 10 months ago I had a go at trueSpace but was not very impressed and deleted it. With the conclusion of his series I thought maybe I had been a bit hasty and downloaded the programme again. Oh Dear! The version on offer is 7.61 and this is the one from which the v6 model view has been deleted.

Never mind, I downloaded version 7.5. This one refuses to open past the enlargement of the program's icon. OK, I will try V7. But this and earlier versions are apparently in the hands of various suppliers who ask for sums from a few dollars up to about \$50, plus, of course, full details of my Visa card, which I am loath to part with to an unknown source.

Can Linton advise? There are probably others trying to download this program and getting a severe case of bitten fingernails as a result!

I'm glad you've started to give us an overview at the beginning of each article. In the old days I sometimes had to read well into the article to appreciate what the author was really getting at!

Finally, can you please let me have a copy of the guidance rules for potential authors of articles. You mentioned them some time ago and I've been meaning to ask for them for some time.

Dennis Murray, by email.

TrueSpace 2

Congratulations on the series of articles on 3D Design by Linton Wedlock in MEW. It will help me in my design of a 4 Cylinder I/C engine. Unfortunately the article had a few typos/misprints along the line, some of which I managed to work out and correct, others I just gave up on. On that score would it be possible to ask the author to run through the article and pick out the mistakes and could you then print a list of corrections in MEW.

I wonder how many readers new to 3D design gave up part way through thinking 'I

WRITE TO US!

We would love to hear your comments & questions and also feedback about MEW

Write to the Editor, David Clark, Model Engineers' Workshop, MyHobbyStore Ltd., PO Box 718, Orpington, Kent BR6 1AP. Alternatively email: david.clark@myhobbystore.com

YOUR CHANCE TO TALK TO US!
Drop us a line and share your advice,
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can't understand any of this' when the objects didn't turn out the way they should?
Pete Worden, by email.

The editor replies: Linton's articles were very well written and changes to the text were negligible. I will ask Linton to check through the articles to see if any corrections are in order.

Overall, with one exception, correspondence about the 3D design series has been very positive. I find I get complaints about CNC series as well, could it be that some readers are not computer literate and don't want to learn? I do try to balance content and select a range of articles that may be of interest to most readers. The average value paid to contributors is more than £2,000 per issue. Add on all the salaries, mine, an illustrator, a layout person, photograph retoucher and various other office based staff and you are probably talking around at least £5,000 worth of value goes into creating an issue of *Model Engineers' Workshop*.

Then we sell it to you for £3.95. I think that is a real bargain and if the occasional article is not to your liking, then please remember the other thousands of pounds of information you receive for your £3.95!

Magazine content

It was with good fortune and a coincidence that I happened to be in a newsagents shop and spotted the first edition of MEW. Looking through the pages I could see that this was the perfect magazine for the hobby engineer and have been buying it ever since. In the last 20 years there has been some great construction items and superb articles on engineering procedures and in that time apart from the advent of CNC the general theme of MEW has not changed much.

I now come to the main reason for writing this letter, namely motor speed control for the lathe or mill, and might make a good article for MEW. It's possible that many hobbyists might not want to

change their lathe/mills but would like to add the luxury of speed control.

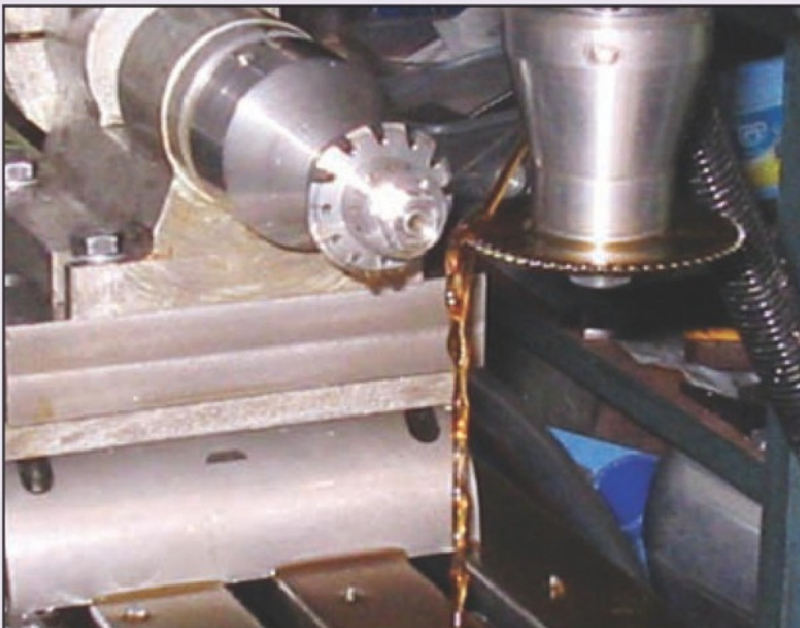
What's wanted now is a competent electronic engineer/designer to come forward and write an article on a practical motor speed control system. It would be convenient if the existent motors could be used in our lathe/mills, these being mostly induction motors. If anyone Googles Microchip Technology Inc application sheet AN984 on the net, there seems to be a real possibility that this could be achieved using a split-phase motor drive, even with the run capacitor in circuit. Unfortunately it does not elaborate on the control circuitry although it seems to use the PIC microcontroller.

I am not an electronic expert and I can see that the electronics could become complicated however, there have been other complicated electronic articles in MEW, EDC/CNC etc. and I for one would welcome such an article.

I would be interesting to hear the comments of other readers on this subject.
W. Watson, Edinburgh.

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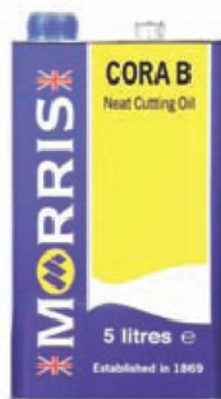
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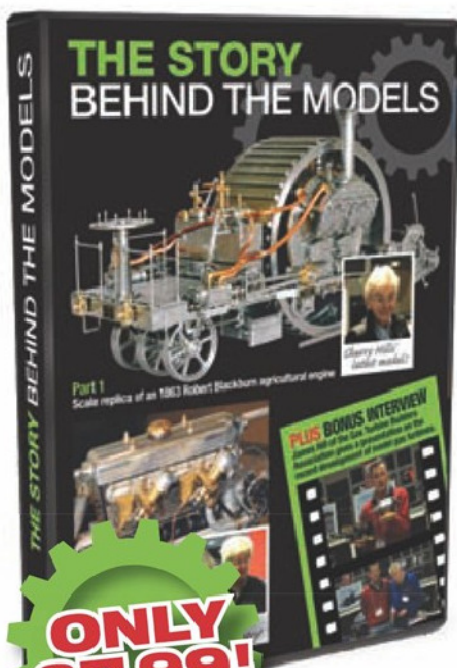
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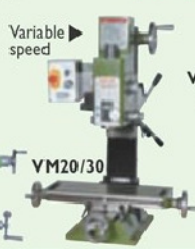
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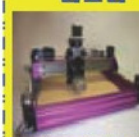
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NEW PRODUCT LAUNCH ANNOUNCEMENT

Live Steam Kits Ltd is pleased to announce the launch of a range of Machined Ready to Build Kits for High Quality Live Steam Locomotives to enable enthusiasts without workshop facilities to build a quality model. They will also appeal to experienced Model Engineers who wish to build and run a live steam locomotive relatively quickly without the need to spend precious leisure time making their own parts.

Based upon our 7 years of experience in building other maker's products within the Lynx Model Works Association of Companies, as well as those of our own manufacture, we are developing a range of working models as self-assembly kits. We are confident that anyone with a basic understanding of Engineering principles will be able to complete a working Live Steam Locomotive from them. After comprehensive research and Prototype Production our first kits will be ready to launch in Early 2010 followed by others throughout the coming years.

Our first offering is a 7 1/2" gauge L & Y "Pug" 0-4-0 Dock Saddle Tank Locomotive, which will be followed later by the 2nd Prototype under development for a more complicated 5" gauge 3 Cylinder Rebuilt Merchant Navy Class Pacific Locomotive and Tender.

These comprehensive kits of parts, boilers and all platework etc, whilst of necessity not inexpensive, will nevertheless build into good quality working models for the discerning enthusiast, with greater scale features than has generally been available thus far.

We also offer a building, painting and lining service to clients who wish us to help further through other parts of our Association of Companies.

For more information please contact :

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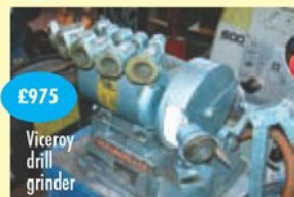


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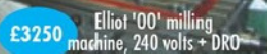
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Elliot '00' vertical/horizontal milling machine. Very nice



SIP NEW (old stock) drilling machines, better quality!

£125



£1400

Boxford Mk111 5" lathe



£140

Pratt production type vice + jaws



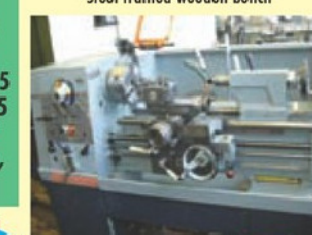
£1250

Wadkin panel saw



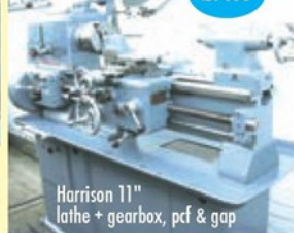
£225

Steel framed wooden bench



Colchester Student 1800 geared / gap bed lathe

£2950



Harrison 11" lathe + gearbox, pcf & gap



NEW £125

Milling/Drilling ground X-Y table



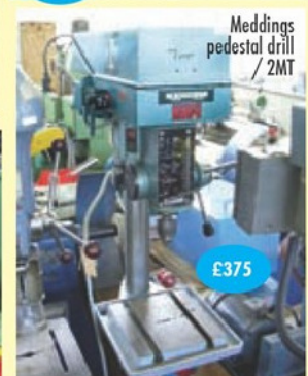
Marico (two speed) broaching press

£475



£3750

Myford 254 PLUS, 240 volts (late model)



£375

Meddings pedestal drill / 2MT



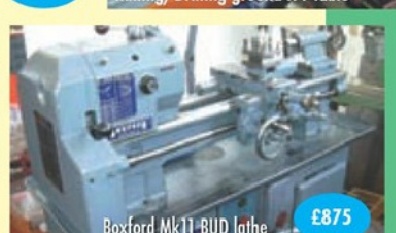
£24

5 kilo anvil



£425

RJH Swordfish fretsaw + extractor



Boxford Mk11-BUD lathe

£875



£2950

Colchester Triumph 2000 + gap & taper turning



£80-£100

Milling cutter sets metric / imperial



£164.50

Crompton/Tyco NEW motor for ML7/Super 7

PLEASE PHONE 0208 300 9070 TO CHECK AVAILABILITY OR TO OBTAIN OUR LIST

DISTANCE NO PROBLEM! DEFINITELY WORTH A VISIT ALL PRICES EXCLUSIVE OF VAT

Just a small selection of our current stock photographed!

We have wood lathes, saw benches, bandsaws, morticers and Record vices etc - large selection!



CHESTER MACHINE TOOLS

www.chestermachinetools.com

NEW
Saturday
Sale days
See below
for details

COBRA LATHE

£299.00



FEATURES

Variable Speed • Thread Cutting • Power Feed •
Cast Iron Bed

STANDARD ACCESSORIES

80mm 3-Jaw Chuck • Toolpost • MT1 Steel Centre •
Change Gears • Splash Guard • Spanners • Variable Speed
• Manual and Parts List

CONQUEST SUPER MILL

End Mill Capacity 12mm
Drilling Capacity 12mm
Table Size 460 x 120mm
Longitudinal Travel 360mm
Cross Travel 120mm
Speeds (Variable) 0-2500rpm
Spindle Taper MT3
Weight 55kgs
Size 490x445x860mm

FEATURES

• Extra Large Table • Variable Speed
• Angled Milling • Guideway Covers
• Dovetail Column • Fine Feed Quill



£520.00

**LONG
TABLE**

626 MILL

£1551.00



FEATURES

• Head Swivels 90 degrees
• Head Tilts 45 degrees
• One Shot Lubrication
• 1.5hp Motor
• Machine Worklight
• Machine Stand

Max Drilling Capacity 32mm
Max End Mill Capacity 25mm
Face Mill Capacity 75mm
Table Size 156 x 745mm
Long Travel 380mm
Cross Travel 135mm
Knee Travel 330mm
Spindle Taper MT3 or R8
Motor 1.5hp
Size 1085x990x1710mm
Net Weight 410kgs

CHAMPION 16VS

£599.00



FEATURES

• Variable Speed Spindle
• Dovetail Column
• Tilting Head
• Wide Spindle Speed Range
Table Size 500 x 140mm
Spindle Taper MT2
Speeds Variable 50-2500rpm
Motor 600w
Weight 90kgs

Shown with optional stand

DB11VS

Centre Distance 700mm
Swing over Bed 280mm
Spindle Bore 26mm
Motor 1200w
Spindle Speeds 125-2500rpm
Net Weight 180kgs

FEATURES

Digital Speed Readout • Variable
Spindle Speed • Metric & Imperial
Thread Cutting

STANDARD ACCESSORIES

3-Jaw Chuck • 4-Jaw Chuck • Coolant
Tray • Rear Splash Guard



£1316.00

Shown with optional stand



**3-Jaw
Chucks
80mm**

£39.10



**Mag
Base and
Dial
Gauge**

£32.78



**4-Jaw
Independent
Chucks
80mm**

£46.36



**6" x 5" x
41/2" Open
Angle Plate**

£28.09



**Quick
Action
Vice
Low
Working
Height**

£32.90



**T1 Quick
Change
Toolpost
and 5
Holders**

£111.62

Chester UK announce "Saturday Sale Days"

— starting from 24th April at our Midlands Showroom 10am - 4pm.

These are to be held once a month on the following dates 24th April, 22nd May, 26th June, 31st
July, 21st August, 25th September, 30th October, 27th November.

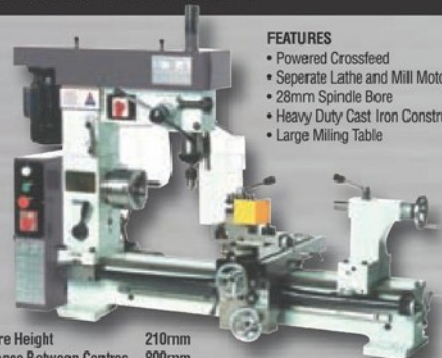
All machines and tooling at Special Prices on these Saturdays only.

Please note after 27th March Chester showroom will be shut on a Saturday.

CENTURION LONG BED

FEATURES

• Powered Crossfeed
• Separate Lathe and Mill Motors
• 28mm Spindle Bore
• Heavy Duty Cast Iron Construction
• Large Milling Table



Centre Height 210mm
Distance Between Centres 800mm
Spindle Taper MT4
Spindle Bore 28mm
Speeds - Lathe 160-1360rpm
Speeds - Mill 120-3000rpm
Drilling Capacity 25mm
End Mill Capacity 28mm
Motors 3/4 h.p.
Size 1570x480x955mm
Weight 300kgs

£1286.00



**Economy
Live Centre**

**MT2 £15.27
MT3 £17.63**



**Magnifier
Lamp**

£35.25



**V Blocks
and
Clamps
1" Capacity**

£10.00



**Machine
Angle Level**

£55.23



**Centre
Punch
Set**

£6.00



**5" Bench Hand
Shears**

£35.25

**6" Bench Hand
Shears**

£45.83



4" ROTARY TABLE

**£148.00
including dividing plates**



**3 Ton
Portable Crane**

£299.00

ALL PRICES INCLUDE VAT AND DELIVERY



Chester Machine Tools, Clwyd Close, Hawarden Industrial Park CHESTER CH5 3PZ

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Southern Showroom: TPH Machine Tools, Fairview Industrial Park, Rainham, Essex, RM13 8UA

T: + 44 (0)1708 523916 email: machines@tphmachinetools.co.uk

